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NATIONAL DAM INSPECTION PROGRAM. LOWER TWIN LAKE DAM (NDI ID NU--ETC(U)
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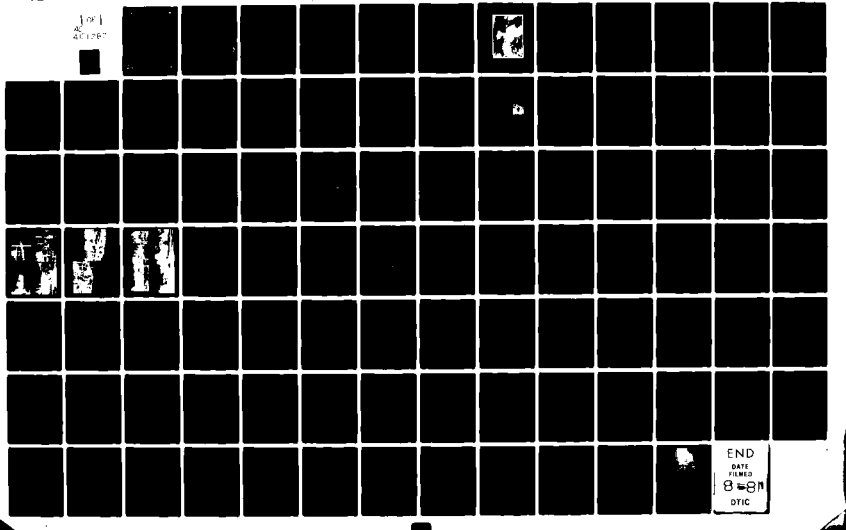

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LEVEL II

DELAWARE RIVER BASIN
BRANCH OF KINNEYVILLE CREEK, WAYNE COUNTY

PENNSYLVANIA

LOWER TWIN LAKE DAM

NDI ID NO. PA-00132
DER ID NO. 64-18

CAMP WAYNE FOR BOYS

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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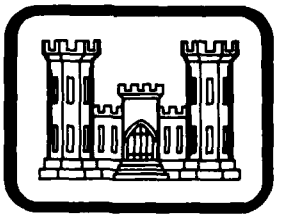

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Prepared by
Geo-Technical Services, Inc.
CONSULTING ENGINEERS & GEOLOGISTS
851 S. 19th Street
Harrisburg, Pennsylvania 17104

For
DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

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DELAWARE RIVER BASIN
BRANCH OF KINNEYVILLE CREEK
WAYNE COUNTY, PENNSYLVANIA

LOWER TWIN LAKE DAM

NDI ID No. PA-00132
DER ID No. 64-18

CAMP WAYNE FOR BOYS

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

National Dam Inspection Program. Lower Twin Lake Dam (NDI ID Number PA-00132, DER ID Number 64-18) Delaware River Basin, Branch of Kinneyville Creek, Wayne County, Pennsylvania. Phase I Inspection Report.

Prepared By

GEO-Technical Services, Inc.
Consulting Engineers & Geologists
851 South 19th Street
Harrisburg, Pennsylvania 17104

Contract DACW31-81-C-0019

For

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS
Baltimore, Maryland 21203

May 1981

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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to identify expediously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonable possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

TABLE OF CONTENTS

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

BRIEF ASSESSMENT OF GENERAL CONDITION

AND

RECOMMENDED ACTION

Name of Dam:	Lower Twin Lake Dam NDI ID No. PA-00132 DER ID No. 64-018
Owner:	Camp Wayne for Boys
State Located:	Pennsylvania
County Located:	Wayne
Stream:	Branch of Kinneyville Creek
Date of Inspection:	December 2, 1980

Based on visual inspection, field survey, and available records, Lower Twin Lake Dam is judged to be in poor conditions. There is no existing spillway to convey flood flows nor means to lower the reservoir level in emergencies.

Based on calculations and according to criteria established for Phase I Dam Inspection Studies, the dam is judged to be unsafe, non-emergency, because of the absence of a spillway. The selected Spillway Design Flood (SDF) for the facility is ½PMF (Probable Maximum Flood). It is judged that the dam could not withstand the depth and duration of overtopping that would occur from a flood magnitude of 0.2 PMF, or greater. Failure of the dam would significantly increase the downstream hazard conditions.

The facility is not properly maintained, as evidenced by the growth of brush and trees on the top of the dam and at the toe.

The following measures are recommended to be undertaken by the owner, in the approximate order of priority, immediately:

(1) Perform additional hydrologic and hydraulic analyses to more accurately determine the required spillway capacity for the Lower Twin Lake Dam. Design and construct a spillway that will pass the required SDF without overtopping the dam.

(2) Remove trees and brush from the top of the earth embankment and the toe of the dam under the supervision of a professional engineer.

(3) Periodically measure the rate and clarity of leakage discharging from the remnant stone culvert. Take appropriate action as necessary.

(4) Develop a method of drawing down the lake in case of emergency.

All investigations, studies, designs, and supervision of construction should be performed by a professional engineer experienced in the design and construction of dams.

In addition, it is recommended that the owner institute operational procedures, as follows:

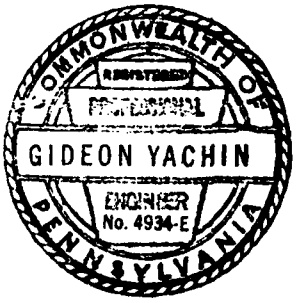
(1) Develop a detailed emergency operation and warning system.

(2) Provide round-the-clock surveillance of the dam during periods of unusually heavy rains

(3) When warnings of storms of major proportions are given by the National Weather Service, the owner should activate his emergency operation and warning system procedures.

(4) Institute an inspection program such that the dam is inspected frequently. As presently required by the Commonwealth, the program should include a formal annual inspection by a professional engineer experienced in the design and construction of dams. Utilize the results to determine if remedial measures are necessary.

(5) Institute a maintenance program to properly maintain all features of the dam.



Submitted by:

GEO-TECHNICAL SERVICES, INC.

Gideon Yachin

GIDEON YACHIN, P.E.

Date: May 13, 1981

Approved by:

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS

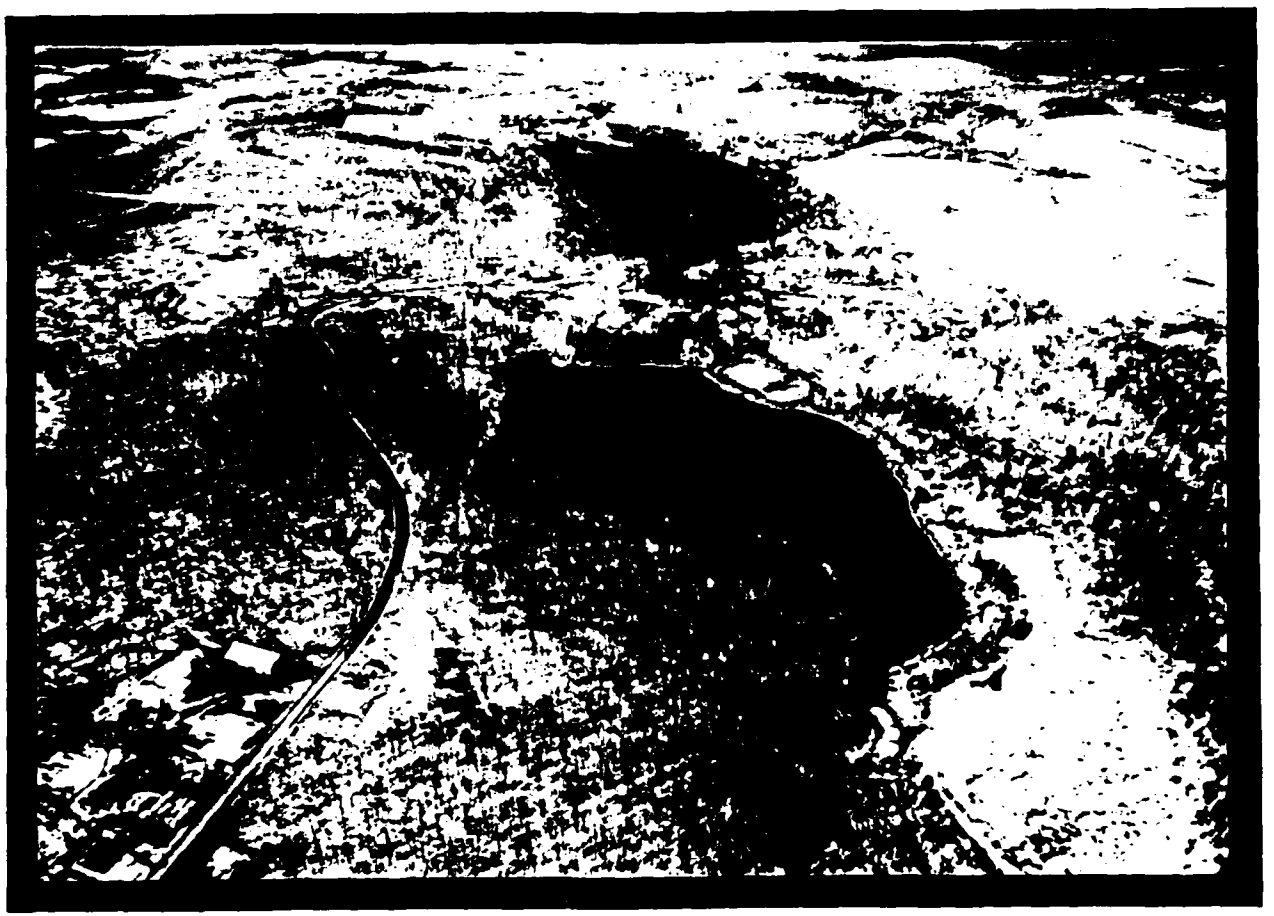
James W. Peck

JAMES W. PECK
Colonel, Corps of Engineers
Commander and District Engineer

Date: 3 JUNE 1981

LOWER TWIN LAKE DAM (PA 00132)

(UPPER TWIN LAKE IN BACKGROUND)



OVERVIEW

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

LOWER TWIN LAKE DAM

NDI# PA-00132, PENNDER # 64-018

SECTION 1

GENERAL INFORMATION

1.1 General.

a. Authority. The inspection was performed pursuant to the authority granted by the National Dam Inspection Act, Public Law 92-367, to the Secretary of the Army, through the Corps of Engineers, to conduct inspections of dams throughout the United States.

b. Purpose. The purpose of this inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project.

a. Dam and Appurtenances: Lower Twin Lake Dam is a composite earthfill masonry structure. There is an earthen embankment upstream. The crest and downstream portion of the dam is an earth fill between dry stone walls. The upstream wall forms the top of the dam and is 3' to 4' higher than the earthfill section and the downstream wall. The dam is 157 feet in length along the upstream wall and 10.3 feet high at the low point on the crest. The crest is 14 feet wide including the downstream and upstream walls.

At the present time, the dam does not have a constructed spillway. High flows pass through a 15 feet wide breached section of the upstream wall and overtop the earthfill section and the downstream stone wall.

The dam does not have an operable outlet works. The remnant of a rectangular (1.8' x 1.9') stone culvert is located at the downstream toe of the dam. The location of the inlet end of the conduit is unknown and probably buried under several feet of sediment.

b. Location. Lower Twin Lake Dam is located on a branch of Kinneyville Creek in Preston Township, Wayne County, Pennsylvania. The dam is situated 0.5 mile north of Lake Como, Pennsylvania, and is shown on the 1978 photo-revised USGS Quadrangle, Lake Como, Pennsylvania, at Latitude N 41°51'16" and Longitude W 75°20'04". A location map is presented in Exhibit E-1.

c. Size Classification. Small (10.3' high, 316 acre-feet maximum storage).

d. Hazard Classification. High hazard. Downstream conditions indicate that a high hazard classification is warranted for Lower Twin Lake Dam (paragraph 3.1e).

e. Ownership. Camp Wayne for Boys, c/o Michael H. Corpal, 570 Broadway, Lynbrook, New York 11563.

f. Purpose of Dam. Recreation.

g. Design and Construction History. Information related to the design and construction of the dam is not available. Data obtained from the Pennsylvania Department of Environmental Resources (PENNDER) indicate that the dam was in existence prior to the 1914 "Survey of Lakes" in Pennsylvania. Inspection reports and photographs indicate the breach in the upstream stone wall occurred prior to 1965. This information is on file with PENNDER.

h. Normal Operating Procedure. The pool is maintained below the dam crest by leakage through the dry stone masonry. Seepage into the upstream wall is passed through the earthfill and into the dry stone culvert.

Flood flows discharge through the breached section of the upstream wall, over the earthfill section and into the natural downstream channel.

1.2 Pertinent Data.

a. Drainage Area.	1.03 Sq. Miles
b. Discharge at Damsite (cfs).	
Maximum known flood at damsite	Unknown
Outlet works at maximum pool elevation	Not Applicable
Spillway capacity at maximum pool elevation	Not Applicable
c. Elevation (feet above msl).	
Top of Dam	
Design conditions	Unknown
Existing conditions (lowest point at breach)	1496.5
Maximum Pool	
Design conditions	Unknown
Existing conditions	1496.5
Normal Pool	1496.5
Upstream Invert Outlet Works	Not Applicable
Downstream Invert	Remnant Stone Culvert
Streambed at Toe of Dam	1486.2
d. Reservoir Length.	
Normal Pool	2100 feet
Maximum Pool	2100 feet
e. Storage.	
Normal Pool	316 Ac.Ft.
Maximum Pool	316 Ac.Ft.
f. Reservoir Surface.	
Normal Pool	34 Acres
Maximum Pool	34 Acres
g. Dam.	
Type	Dry stone masonry and earthfill
Length (feet)	157
Height (feet)	10.3
Top Width (feet)	14
Side Slopes	Downstream 5V:1H, Upstream 1V:3.3H
Zoning	Unknown
Cut-off	Unknown
Grout Curtain	Unknown

h.	Diversion and Regulating Tunnel.	None
i.	Spillway.	None
	Type	Not Applicable
	Length of Weir	Not Applicable
	Crest Elevation	Not Applicable
	Upstream Channel	Not Applicable
	Downstream Channel	Not Applicable
j.	Regulating Outlets.	None
	Type	Not Applicable
	Length	Not Applicable
	Closure	Not Applicable
	Access	Not Applicable

SECTION 2

ENGINEERING DATA

2.1 Design.

a. Data Available. There is no information available relative to the design of the Lower Twin Lake Dam.

b. Design Features. Inspection reports and accompanying photographs from 1924 and 1930 indicate that the upstream wall was originally lined with wood planking. They also imply that the remnant stone culvert, presently visible at the downstream end, served as the outlet works.

2.2 Construction.

No information concerning construction of the dam is available.

2.3 Operation.

There are no records available to indicate the past operational procedures for the dam. The present normal operation of the facility is described in paragraph 1.2h, Section 1.

2.4 Other Information.

On-site inspections were made in July 1924, June 1930, May 1931, June 1934, and April 1965.

2.5 Evaluation.

a. Availability. The previously cited inspection reports were provided by the Bureau of Dams and Waterway Management, Department of Environmental Resources (PENNDER), Commonwealth of Pennsylvania. The Owner's representative had no information related to the design, construction or the operation of the dam. Pertinent dam features were obtained by survey on the inspection date (12/02/80). There are no other sources of information available for the evaluation of the facility.

b. Adequacy. The available data is very limited and the dam safety assessment must be primarily based on the visual inspection, performance history and the hydrologic and hydraulic analyses, presented in Section 5. The collected data are considered adequate for Phase I report.

c. Validity. There is no reason to question the validity of the available data.

SECTION 3

VISUAL INSPECTION

3.1 Observations.

a. General. The overall appearance of the dam is poor. Location of observed deficiencies are shown on the General Plan presented in Exhibit A-1, Appendix A. The profile and typical sections of the dam are presented in Exhibits A-2 and A-3 and are based on field survey made on the day of inspection. The survey datum for this inspection is elevation 1495 feet above mean sea level for the normal water surface of the lake (see Exhibit E-1). On the inspection date (12/02/80), the lake level was approximately at elevation 1495, which is 1.5 feet below the low point on the dam crest (see Exhibit A-3). Deficiencies observed during the field inspection are described below, and are further illustrated in Exhibit A-1, Appendix A. Visible features are depicted in photographs presented in Appendix C.

b. Dam. Observations made during the inspection indicate that the earth and dry stone masonry dam is in poor condition. On the upstream side of the dam, a vertical dry stone wall, about 3.5 feet wide and 157 feet long, extends 3 to 4 feet above the top of the earth embankment (see photographs 1 and 2, Appendix C). The top of the wall is not horizontal and rises on both abutments (see Exhibit A-2). Approximately 15 feet of this wall is breached on the left side to a low point on the dam at elevation 1496.5 (see photograph 4, Appendix C). Upstream of this wall, an earth embankment slopes 1 vertical on 3.3 horizontal to a maximum depth of 3 feet below the lake level. Upstream for a distance of about 300 feet, the original stream channel is filled in with earth to about 3 feet below lake level. The downstream side of the dam is a dry stone masonry wall with a batter of 5 vertical to 1 horizontal. The downstream wall is about 73 feet long and 10.3 feet high at its maximum section. A rectangular opening (1.8'W x 1.9'H) in the low point in the stone wall was discharging water at about 250 GPM (see photograph 3, Appendix C). This flow appears to be entirely leakage, since no intake structure or controls were visible. This is supported by the sound of turbulent flow below the right side of the breach in the upstream wall (see Exhibit A-1). No accumulation of fines was observed in the discharge area. The top of the dam is 14 feet wide and contains earth fill between the dry stone walls (see photograph 2, Appendix C). Except for the low area in the vicinity of the breached upstream wall, the top of the earth fill is essentially horizontal. Brush and trees up to 8" in diameter are located on the dam crest and along the toe of the downstream wall.

c. Appurtenant Structures.

(1) Spillway: There is no visible evidence of a constructed spillway. When inflow into the lake exceeds leakage through the dam, excess flow is discharged through the 15 feet wide breached section in the upstream wall.

(2) Outlet Works: The rectangular opening (1.8'W x 1.9'H) at the low point in the downstream wall appears to be a remnant drain outlet (see photograph No. 3). There was no visible evidence of an intake or con-

trol facilities. On the day of the field inspection, the outlet was discharging about 250 GPM. This flow represents the entire inflow into the lake and appears to be controlled seepage and leakage through the dam.

d. Reservoir Area. With the exception of about 7 acres of farmland on the left abutment, the watershed is predominantly undeveloped woodland. The left abutment slopes vary from 15 to 30 percent and contain many large, slabby, sandstone boulders. The right abutment slopes vary from 5 to 15 percent. There is no evidence of unstable slope conditions or features that could affect the safety of the dam. Approximately 800 feet upstream of Lower Twin Lake is Upper Twin Lake. The impact of this lake on Lower Twin Lake is described in Section 5, Hydrology and Hydraulics. Other pertinent watershed features are shown in Exhibit E-1, Appendix E. The geologic conditions in the area are described in Appendix F.

e. Downstream Channel. The channel downstream of the dam is a natural wooded channel with an average slope of about 5 percent (see photograph No. 5, Appendix C). About 300 feet downstream of the dam, the stream flow is diverted into a man-made earth channel (see photograph No. 6, Appendix C). The channel varies from 8 to 10 feet wide and has a 3-foot high embankment with 1 on 2 slopes on the downhill side. This channel is diverted left of the natural stream valley and discharges into an adjacent stream about 500 feet east. Large flows exceeding the capacity of the man-made channel flow down the original stream valley. After crossing the highway 900 feet downstream, the stream valley widens and combines with the flat flood plain of Kinneyville Creek. There are six occupied homes 650 to 1300 feet downstream that would be extensively damaged and more than a few lives could be lost should the dam fail (see photograph Nos. 7 and 8, Appendix C). Consequently, Lower Twin Lake Dam is classified as a high hazard structure.

SECTION 4

OPERATIONAL PROCEDURES

4.1 Normal Operating Procedure.

The reservoir is maintained at normal pool level with the excess inflow discharging as leakage through the dam which flows out of the rectangular opening at the toe of the downstream dry stone wall. Previous inspection reports on the dam revealed that this condition existed prior to 1940.

4.2 Maintenance of Dam.

Maintenance activities by the present owner could not be ascertained during the inspection and appear to be minimal. Visual inspection of the dam indicates that there has been little or no maintenance of the dam. Several trees on the dam have grown to 8-inches in diameter.

4.3 Maintenance of Operating Facilities.

There are no visible operable outlet facilities at the dam. The flow in the remnant stone culvert drain is uncontrolled leakage and seepage through the dam.

4.4 Warning System.

There is no emergency operation and warning system in effect at the present time.

4.5 Evaluation.

There is no formal inspection and maintenance program in effect. Frequent inspections are necessary to detect hazardous conditions at the dam.

An emergency warning system and evacuation plan for the downstream residents is necessary to prevent loss of life should the dam fail.

SECTION 5

HYDROLOGY AND HYDRAULICS

5.1 Design Data.

There is no design information available for Lower Twin Lake Dam.

5.2 Experience Data.

No records of prior flood stages or flows are available for Lower Twin Lake Dam, the upstream Upper Twin Lake Dam, or Kinneyville Creek, downstream of the facility.

5.3 Visual Observations.

Based on the visual inspection reported in Section 3, the observations relevent to hydrology and hydraulics are evaluated below:

a. Dam. In the absence of a spillway, the breached portion of the upstream wall conveys flood water over the dam into the downstream channel. A profile of the upstream stone wall is presented in Exhibit A-2.

Photographs from inspection reports and visual observations indicate that the dam was constructed to increase the level of a natural lake. For a distance of about 300 feet upstream of the dam, the original stream channel has been filled in by lake sediments or by man-placed soils to about elevation 1492. Should the dam fail, only the water impounded above elevation 1492 would contribute to downstream flooding conditions.

b. Upstream Conditions. About 800 feet upstream of Lower Twin Lake is Upper Twin Lake Dam, as shown on Exhibit E-1. The effect of this upstream dam and reservoir on the hydrologic and hydraulic characteristics of Lower Twin Lake Dam is described in Appendix D and summarized in paragraph 5.5b.

c. Downstream Conditions. There are no downstream conditions which would affect the hydraulic analysis of the dam. The diversion channel, described in paragraph 3.1e, has no significant effect on downstream conditions during floods.

5.4 Method of Analysis.

Hydrologic and hydraulic evaluation was made in accordance with the procedures and guidelines established by the U.S. Army Corps of Engineers, Baltimore District, Phase I Safety Inspection of Dams. The analysis has been performed utilizing the HEC-1DB program developed by the U.S. Army Corps of Engineers, Hydrologic Engineering Center, Davis, California. A brief description of program capabilities, as well as the input and output data used specifically for this analysis , is presented in Appendix D.

5.5 Summary of Analysis.

a. Spillway Design Flood (SDF). According to criteria established by the Office of the Chief of Engineers (OCE), the Spillway Design Flood (SDF) for the size (small) and the hazard potential (high) of the Lower Twin Lake Dam is between one-half Probable Maximum Flood (½PMF) and the full PMF. Based on the potential hazard survey and the hydrologic and hydraulic analysis, ½PMF is selected for the SDF for Lower Twin Lake Dam.

b. Results of Analysis. The analysis indicates that the Lower Twin Lake Dam overtops by 1.5 and 3.1 feet during flood magnitudes of 0.2 PMF and 0.5 PMF respectively. In the absence of a spillway, the duration of overtopping, for all flood magnitudes analyzed, is 48 hours.

It was judged that overtopping depth of one foot over the crest of the earth embankment would breach the dam within a period of 15 minutes. Dam break analysis was performed with a breach width equal to the existing 15 feet wide breach in the upstream stone wall. Since the dam was constructed at the outlet of a natural lake, failure of the dam would only release the impounded water above the outlet of the natural lake (see Appendix D, Sheet D-15).

Comparison between the "overtopping" analysis and the "dam breach" analysis indicates that the maximum flood stage resulting from the breaching of the dam would occur considerably sooner and would be higher that that derived for the "overtopping" analysis. For flood magnitudes of 0.2 PMF, the aforementioned comparison indicates that the difference between the attained maximum flood stages is 2.25 hours. The computed maximum flood stage difference at the first group of dwellings, downstream of the dam, is 3.4 feet. This will increase the hazard to loss of life and property damage.

The analysis indicates that Upper Twin Lake Dam would be overtopped at the ½PMF by a maximum depth of 0.7 feet and that the duration of overtopping would be 5.75 hours. It is judged that the Upper Twin Lake Dam would not fail due to overtopping under these conditions.

A summary of computer analysis is tabulated at the end of Appendix D.

c. Spillway Adequacy. Lower Twin Lake Dam is rated as seriously inadequate because there is no spillway capable of passing floods without overtopping the dam. Failure of the dam would increase downstream flooding conditions above those existing prior to the failure and increase hazard to loss of life.

SECTION 6

EVALUATION OF STRUCTURAL STABILITY

6.1 Visual Observations.

The visual inspection reported in Section 3 resulted in a number of observations relative to the structural stability of the dam as described below.

a. Embankment. The brush and trees growing on the dam crest and along the toe are undesirable. The trees promote structural deterioration of the dry stone walls and create potential piping paths in the embankment.

b. Spillway. The lack of a spillway causes flood flows to be discharged over the dam crest. A fifteen-foot section of the upstream wall has been breached and the downstream wall has had several stones removed by erosion. Subsequent high discharges will increase this structural deterioration to the point of total failure.

c. Outlet Works. All low flow discharges pass through the embankment and dry stone walls of the sturcture as leakage. While no evidence of piping was observed, the possibility of piping developing in the future cannot be ruled out.

6.2 Past Performance.

The absence of discernible settlement, bulging, and misalignment combined with the lack of any reported distress over a recorded history of 57 years indicates that the structure is stable under conditions other than severe overtopping.

6.3 Seismic Stability.

The dam is located in Seismic Zone 1. Normally, in this zone, it is assumed that if the dam has an adequate safety factor under static conditions, it can be assumed safe for dynamic earthquake loadings. Based on visual inspections, the dam's age, and past performance, the dam is judged to be stable under static conditions.

SECTION 7

ASSESSMENT, RECOMMENDATIONS AND PROPOSED REMEDIAL MEASURES

7.1 Dam Assessment.

a. Safety.

(1) Based on visual inspection, available records, calculations, and past performance, Lower Twin Lake Dam is judged to be in poor condition. Since the dam has no spillway, it is not capable of passing any portion of the PMF without overtopping. In the absence of a spillway, and based on the type of construction and the condition of the dam, it is judged that the dam could not withstand the depth and duration of overtopping that would occur for the selected SDF (½PMF). Failure of the dam would cause an increased hazard to loss of life downstream. The facility is rated as seriously inadequate. According to criteria established for these studies, the dam is rated as unsafe, non-emergency, as the facility is seriously inadequate.

(2) There is no functional outlet works for the dam.

(3) A summary of the features and observed deficiencies is listed below:

Feature and Location	Observed Deficiencies
Spillway	Non-existent
Outlet Works	Not Functional
Dry Masonry Structure	Stones missing and displaced; clear seepage at toe.
Embankment	Brush and trees.

(4) The facility is not properly maintained, as evidenced by the growth of brush and trees on top of the dam and at the toe.

b. Adequacy of Information. The information available is such that an assessment of the condition of the dam must be based primarily on the visual inspection and computations performed as part of this study.

c. Urgency. The recommendations in paragraph 7.2 should be implemented immediately.

d. Necessity for Further Investigations. In order to accomplish some of the remedial measures outlined in paragraph 7.2, further investigations by a professional engineer, experienced in the design and construction of dams, will be necessary.

7.2 Recommendations and Remedial Measures.

a. The following measures are recommended to be undertaken by the owner, in approximate order of priority, immediately:

(1) Perform additional hydrologic and hydraulic analyses to more accurately determine the required spillway capacity for the Lower Twin Lake Dam. Design and construct a spillway that will pass the required SDF without overtopping the dam.

(2) Remove trees and brush from the top of the earth embankment and the toe of the dam under the supervision of a professional engineer.

(3) Periodically measure the rate and clarity of the leakage discharging from the remnant stone culvert. Take appropriate action as necessary.

(4) Develop a method of drawing down the lake in case of emergency.

All investigations, studies, designs and supervision of construction should be performed by a professional engineer, experienced in the design and construction of dams.

b. In addition, it is recommended that the owner institute operational procedures as follows:

(1) Develop a detailed emergency operation and warning system.

(2) Provide round-the-clock surveillance of the dam during periods of unusually heavy rains.

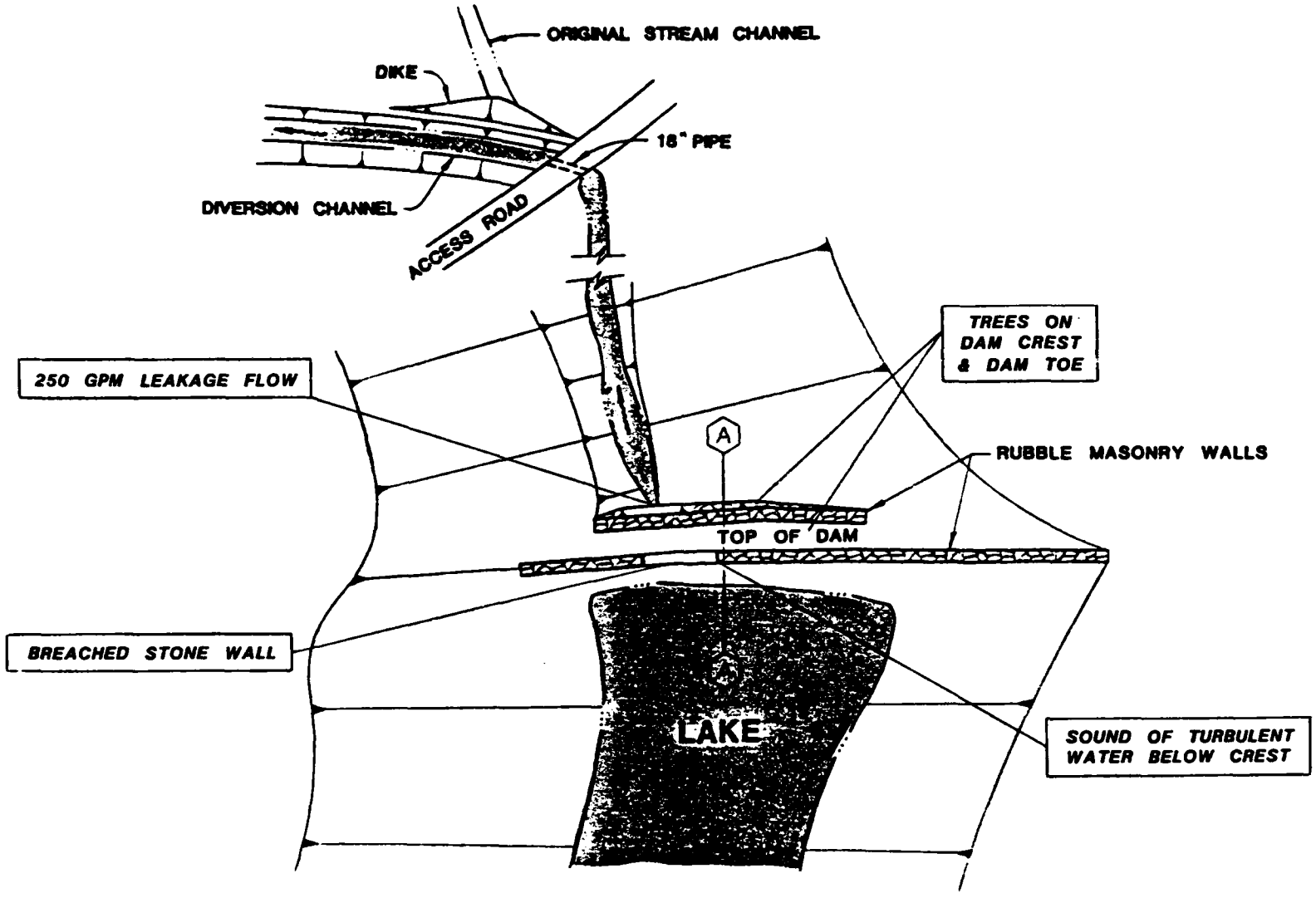
(3) When warnings of storms of major proportions are given by the National Weather Service, the owner should activate his emergency operation and warning system procedures.

(4) Institute an inspection program such that the dam is inspected frequently. As presently required by the Commonwealth, the program should include a formal annual inspection by a professional engineer, experienced in the design and construction of dams. Utilize the results to determine if remedial measures are necessary.

(5) Institute a maintenance program to properly maintain all features of the dam.

APPENDIX A

VISUAL INSPECTION - CHECKLIST AND FIELD SKETCHES



LOWER TWIN LAKE DAM
GENERAL PLAN - FIELD INSPECTION NOTES

EXHIBIT A-1

LOWER TWIN LAKE DAM

TOP OF DAM PROFILE

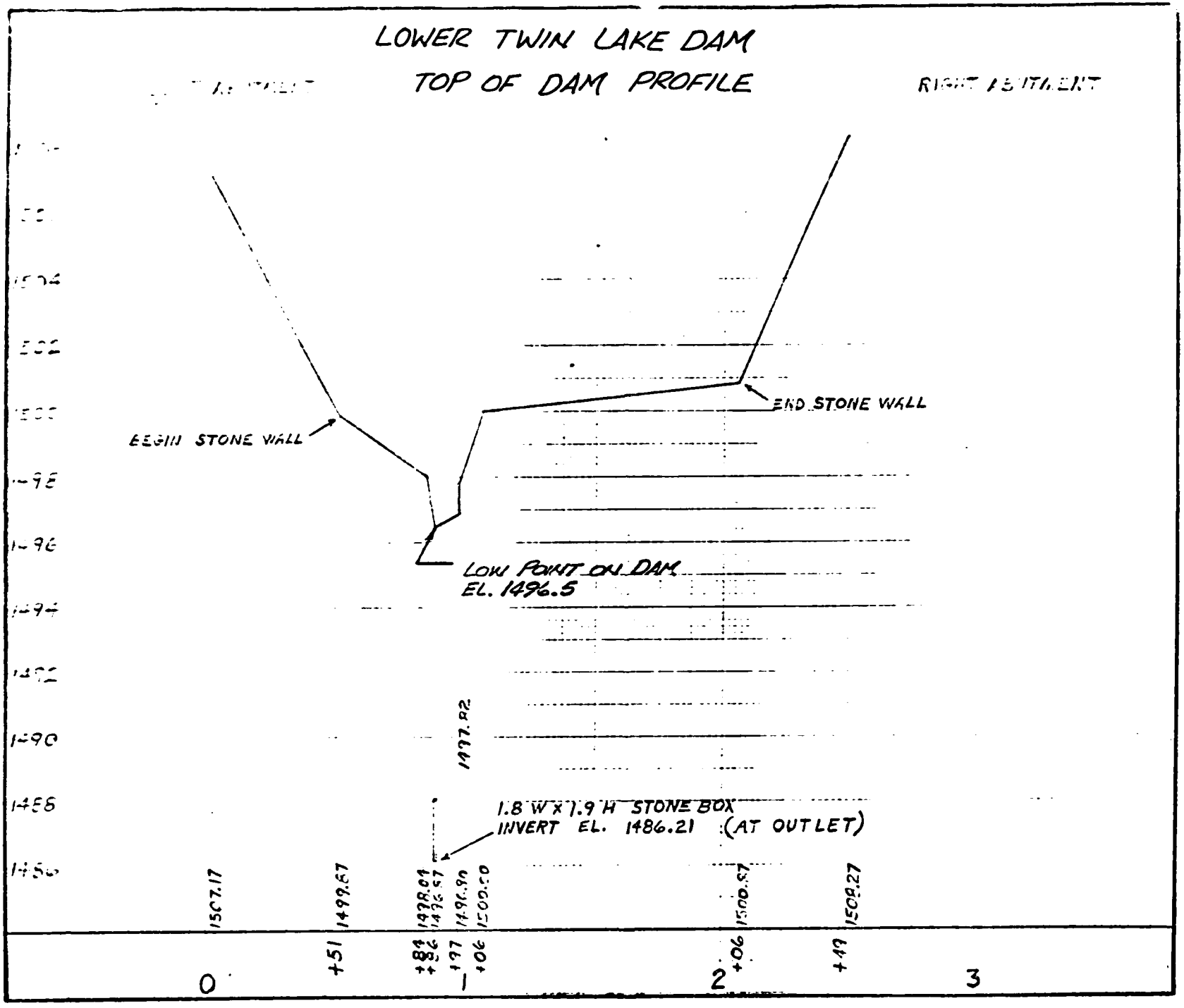
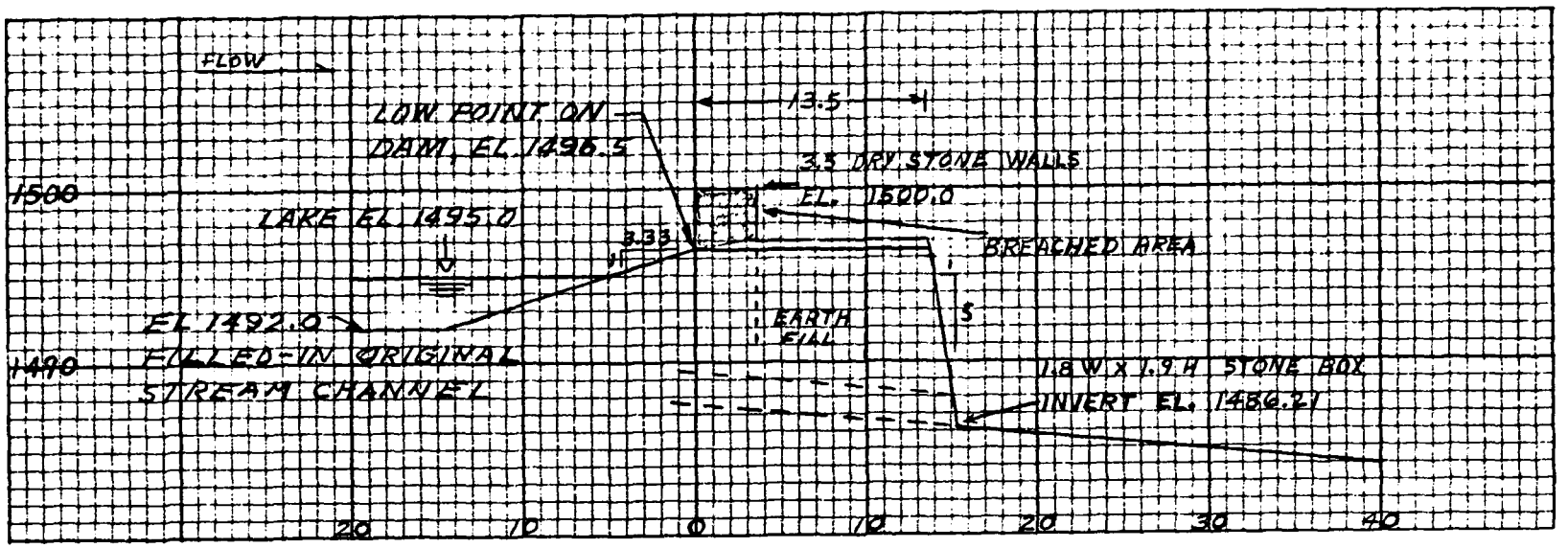


EXHIBIT A-2

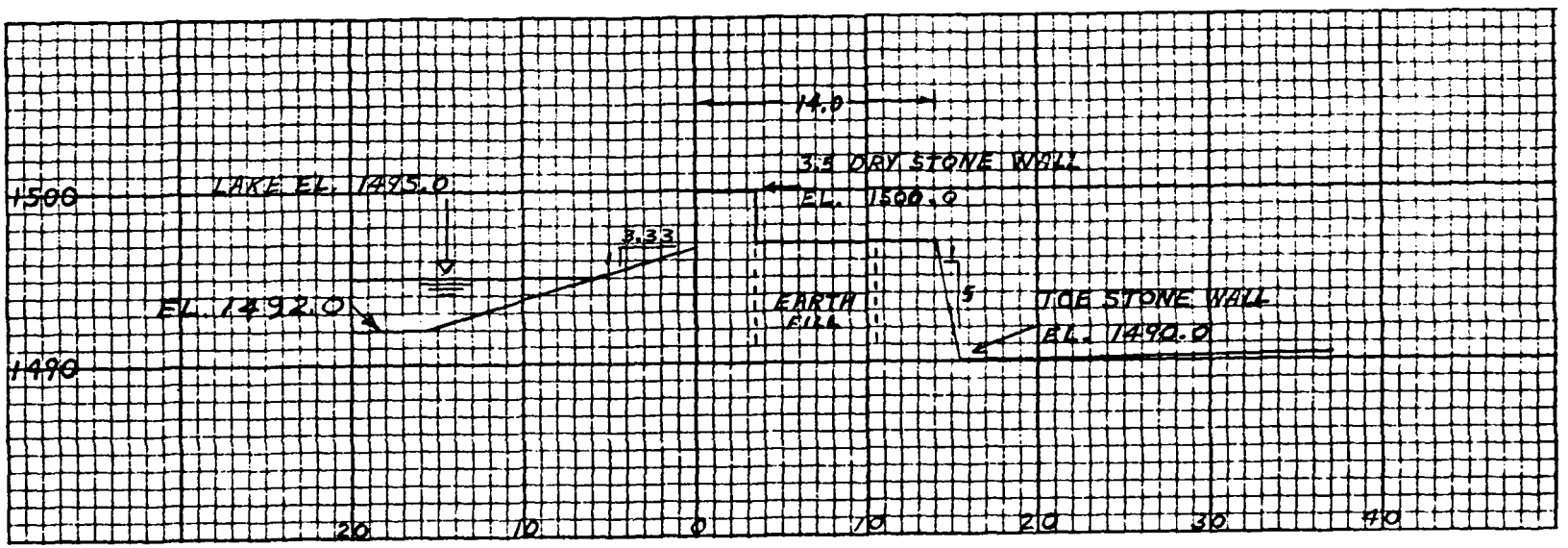
GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

SCALE HORIZ. 1" = 50' VERT. 1" = 4'

TYPICAL DAM SECTIONS



OUTLET SECTION



SECTION A

EXHIBIT A-3

CHECK LIST
VISUAL INSPECTION
PHASE 1

NAME OF DAM Lower Twin Lake STATE Pennsylvania COUNTY Wayne

NDI # PA — 00132 PENNDER # 64-018

TYPE OF DAM Dry Rock Masonry w/Earth Fill SIZE Small HAZARD CATEGORY High

DATE(S) INSPECTION December 2, 1980 WEATHER Clear TEMPERATURE 50° @ 1:30

POOL ELEVATION AT TIME OF INSPECTION 1495 M.S.L

TAIL WATER AT TIME OF INSPECTION N/A M.S.L

INSPECTION PERSONNEL	OWNER REPRESENTATIVES	*OTHERS*
Vaden Butler, Engineer	None	
James Diaz, Geologist		
Wayne Himes, Surveyor		

RECORDED BY Vaden Butler, P.E.

EMBANKMENT

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00132
SURFACE CRACKS	None Visible
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	None
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Horizontal - Good Vertical - Slight sag in middle
RIPRAP FAILURES	About 15' of upstream loose stone wall is breached and stones dumped at downstream toe. Sounds of turbulent water below right side of breach.
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Good; No visible seepage or erosion

EMBANKMENT

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA- 00132
DAMP AREAS IRREGULAR VEGETATION (LUSH OR DEAD PLANTS)	None
ANY NOTICEABLE SEEPAGE	Discharge at box drain appears to be leakage.
STAFF GAGE AND RECORDER	None
DRAINS	1.8' wide x 1.9' high drain visible only from downstream side. Entire flow in stream (250 GPM) emerging at this drain.
ROCK OUTCROPS	None visible at dam site. Many large slabs of boulder talus on right slope and in creek bed indicates shallow bedrock depth. 350 feet downstream of dam, near horizontal sandstone, bedrock ledges are exposed on the creek side slopes.
DAM FOUNDATION TREES, OTHER	Trees and brush on dam crest up to 8" in diameter.

OUTLET WORKS

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA-00132
INTAKE STRUCTURE	None
OUTLET CONDUIT (CRACKING AND SPALLING OF CONCRETE SURFACES)	Outlet concealed in box (1.8' W. X 1.9' H.) in dry stone wall.
OUTLET STRUCTURE	None visible
OUTLET CHANNEL	Natural stream bed about 10' wide.
GATE(S) AND OPERATIONAL EQUIPMENT	None

EMERGENCY SPILLWAY

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00132
TYPE AND CONDITION	All that might be construed as emergency spillway is a breach in the upstream dry stone wall about 15 feet wide (see Exhibit A-2).
APPROACH CHANNEL	Filled stream channel 50' to 75' wide, about 300' long and about 2.5' deep.
SPILLWAY CHANNEL AND SIDEWALLS	None
STILLING BASIN PLUNGE POOL	None
DISCHARGE CHANNEL	Natural stream with 10'± bottom width.
BRIDGE AND PIERS EMERGENCY GATES	None

SERVICE SPILLWAY

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00132
TYPE AND CONDITION	No spillway. In case of very large flood, discharge would be through the breached dry stone wall and over entire length of dam.
APPROACH CHANNEL	N/A
OUTLET STRUCTURE	N/A
DISCHARGE CHANNEL	N/A

INSTRUMENTATION

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA · 00132
MONUMENTATION SURVEYS	None
OBSERVATION WELLS	None
WEIRS	None
PIEZOMETERS	None
OTHERS	
OPERATION AND MAINTENANCE DATA	No maintenance in at least 25 years.

RESERVOIR AREA AND DOWNSTREAM CHANNEL

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00132
SLOPES: RESERVOIR	Right abutment slopes 10 to 15 percent and is wooded. Left abutment slopes 5 to 10 percent and is wooded.
SEDIMENTATION	Sedimentation or man-placed soils has filled original stream channel to within 3.0' of water surface for a distance of about 300 feet upstream of the dam.
DOWNSTREAM CHANNEL (OBSTRUCTIONS, DEBRIS, ETC.)	Normal channel for mountain stream.
SLOPES: CHANNEL VALLEY	Natural wooded stream valley
APPROXIMATE NUMBER OF HOMES AND POPULATION	7 occupied homes - 800-1200' downstream and south of road.
WATERSHED DESCRIPTION	Wooded mountainous area.

APPENDIX B

ENGINEERING DATA - CHECKLIST

CHECK LIST
ENGINEERING DATA
PHASE I

NAME OF DAM Lower Twin Lake

NDI# PA-00132

ITEM	REMARKS
PERSONS INTERVIEWED AND TITLE	Jessie Young, Caretaker
REGIONAL VICINITY MAP	See Exhibit E-1, Appendix E
CONSTRUCTION HISTORY	None Available
AVAILABLE DRAWINGS	None
TYPICAL DAM SECTIONS	See Exhibit A-3, Appendix A
OUTLETS: PLAN DETAILS DISCHARGE RATINGS	 None available None available None Available

CHECK LIST
ENGINEERING DATA
PHASE I
(CONTINUED)

ITEM	REMARKS NDI# PA - 00132
SPILLWAY PLAN SECTION DETAILS	None
OPERATING EQUIP- MENT PLANS AND DETAILS	None
DESIGN REPORTS	None
GEOLOGY REPORTS	Information on sub-surface conditions at the damsite is not available. Geologic description of the site, extracted from "Groundwater in NE Pennsylvania, Bulletin W-4", Pennsylvania Topographic and Geologic Survey, 1937; and is presented in Appendix F.
DESIGN COMPUTATIONS: HYDROLOGY AND HYDRAULICS STABILITY ANALYSES SEEPAGE ANALYSES	None
MATERIAL INVESTIGATIONS: BORING RECORDS LABORATORY TESTING FIELD TESTING	None

CHECK LIST
ENGINEERING DATA
PHASE I
(CONTINUED)

ITEM	REMARKS	NDI# PA-00132
BORROW SOURCES	Unknown	
POST CONSTRUCTION DAM SURVEYS	None	
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None	
HIGH POOL RECORDS	None	
MONITORING SYSTEMS	None	
MODIFICATIONS	None	

CHECK LIST
ENGINEERING DATA
PHASE I
(CONTINUED)

ITEM	REMARKS	NDI# PA- 00132
PRIOR ACCIDENTS OR FAILURES	None reported	
MAINTENANCE RECORDS MANUAL	None	
OPERATION RECORDS MANUAL	None	
OPERATIONAL PROCEDURES	Self-regulating.	
WARNING SYSTEM AND/OR COMMUNICATION FACILITIES	None	
MISCELLANEOUS		

CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

NDI ID # 00132
PENNDER ID # 064-018

SIZE OF DRAINAGE AREA: 1.03 sq. mi.

ELEVATION TOP NORMAL POOL: 1496.5 STORAGE CAPACITY: 316 ac. ft.

ELEVATION TOP FLOOD CONTROL POOL: NA STORAGE CAPACITY: NA

ELEVATION MAXIMUM DESIGN POOL: N/A STORAGE CAPACITY: NA

ELEVATION TOP DAM: 1496.5 STORAGE CAPACITY: 316 ac. ft.

SPILLWAY DATA NOT APPLICABLE

CREST ELEVATION:

TYPE: No existing spillway

CREST LENGTH:

CHANNEL LENGTH:

SPILLOVER LOCATION:

NUMBER AND TYPE OF GATES:

OUTLET WORKS NOT APPLICABLE EXCEPT AS NOTED

TYPE: None visible.

LOCATION:

ENTRANCE INVERTS: Not visible. Appears to be buried.

EXIT INVERTS: Elev. 1486.2

EMERGENCY DRAWDOWN FACILITIES: None

HYDROMETEOROLOGICAL GAGES

TYPE: N/A

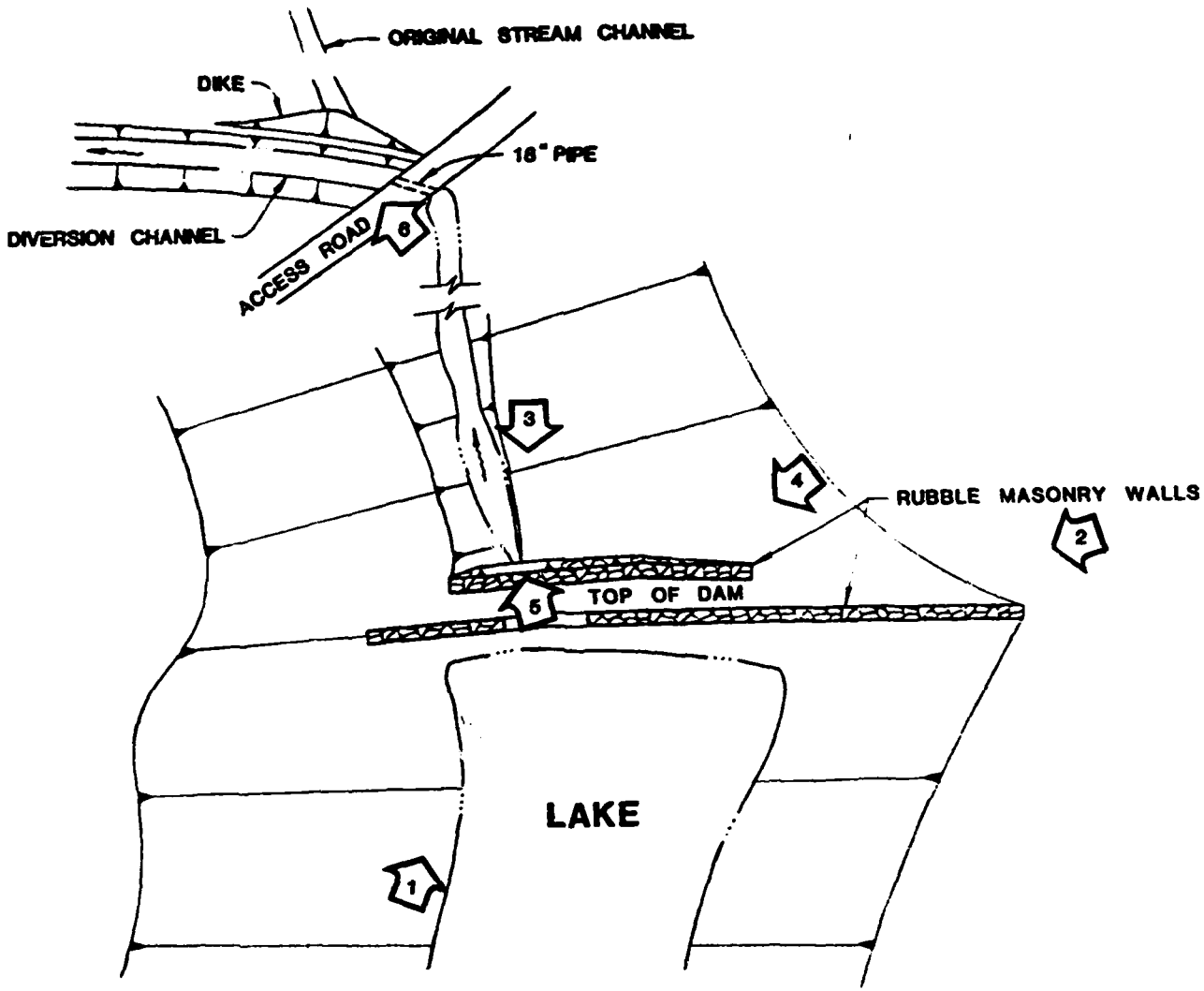
LOCATION:

RECORDS:

MAXIMUM NON-DAMAGING DISCHARGE: Unknown

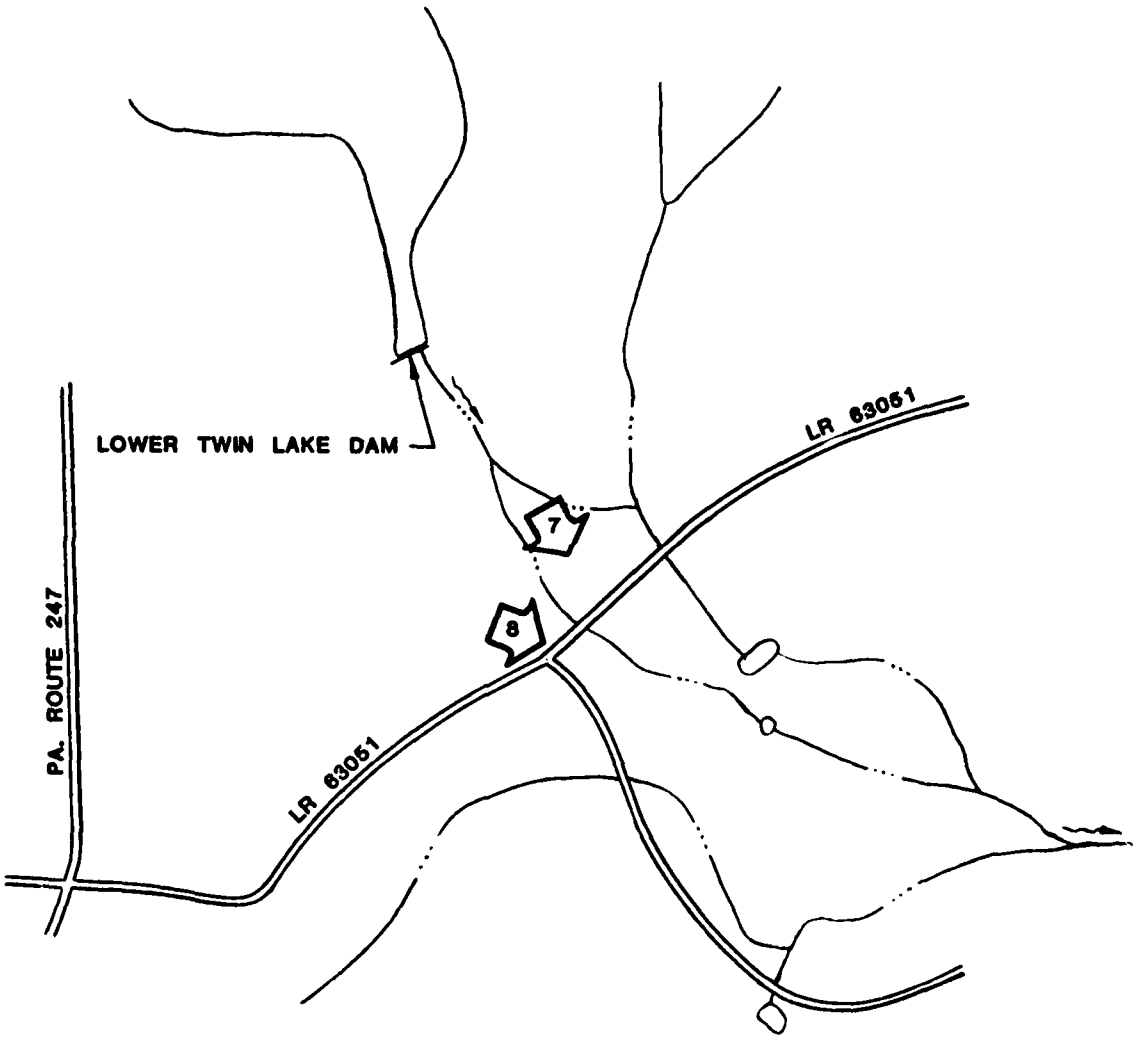
APPENDIX C

PHOTOGRAPHS



LOWER TWIN LAKE DAM
PHOTOGRAPHS LOCATION MAP

EXHIBIT C-1



LOWER TWIN LAKE DAM
DOWNSTREAM PHOTOGRAPHS LOCATION MAP

EXHIBIT C-2

1. UPSTREAM FACE OF DAM

2. TOP OF DAM FROM RIGHT ABUTMENT SHOWING UPPER DRY MASONRY WALL

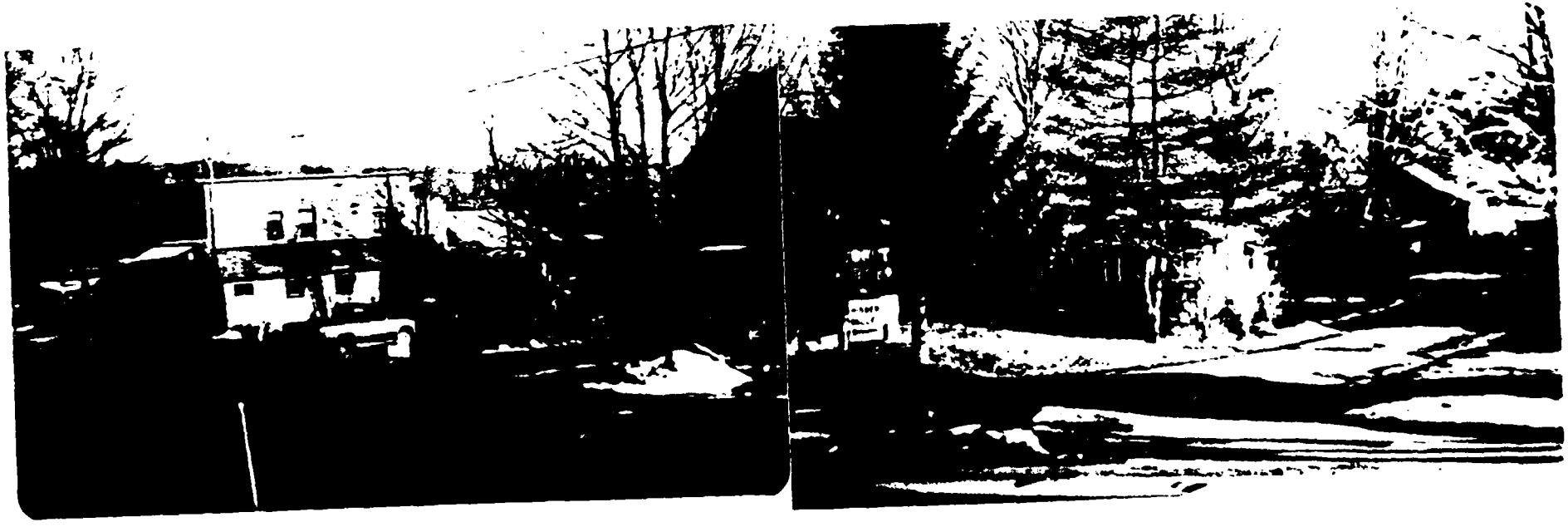
3. DOWNSTREAM FACE OF DRY STONE WALL SHOWING OUTLET OPENING

4. UPPER & LOWER DRY MASONRY WALL SHOWING BREACH AREA

5. DOWNSTREAM VIEW OF STREAM CHANNEL FROM DAM

6. DOWNSTREAM VIEW OF DIVERSION CHANNEL (ARROW TO LEFT) AND ORIGINAL CHANNEL (ARROW TO TOP)

7. DOWNSTREAM VIEW OF HOMES 1000' BELOW DAM



8. EASTWARD VIEW FROM ROAD OF HOMES 1000' BELOW DAM

APPENDIX D

HYDROLOGY AND HYDRAULICS

SUMMARY DESCRIPTION
OF
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY INVESTIGATIONS

The hydrologic and hydraulic evaluation for this inspection report has employed computer techniques using the Corps of Engineers computer program identified as the Flood Hydrograph Package (HEC-1) Dam Safety Version.

The program has been designed to enable the user to perform two basic types of hydrologic analyses: (1) the evaluation of the over-topping potential of the dam, and (2) estimate the downstream hydrologic-hydraulic consequences resulting from assumed structural failures of the dam. A brief summary of the computation procedures typically used in the dam over-topping analysis is shown below.

- Development of an inflow hydrograph to the reservoir.
- Routing of the inflow hydrograph(s) through the reservoir to determine if the event(s) analyzed would overtop the dam.
- Routing of the outflow hydrograph(s) of the reservoir to desired downstream locations. The results provide the peak discharge, time of the peak discharge and maximum stage of each routed hydrograph at the outlet of the reach.

The output data provided by this program permits the comparison of downstream conditions just prior to a breach failure with that after a breach failure and the determination as to whether or not there is a significant increase in the hazard to loss of life as a result of such a failure.

The results of the studies conducted for this report are presented in Section 5.

For detailed information regarding this program, refer to the Users Manual for the Flood Hydrograph Package (HEC-1), Dam Safety Investigations prepared by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California.

GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

JOB LOWER TWIN LAKE PA-00132
SHEET NO ____ OF ____
CALCULATED BY WEH DATE 2/13/81
CHECKED BY ____ DATE ____
SCALE ____

1.) DEVELOP INFLOW HYDROGRAPH TO UPPER TWIN LAKE

2.) ROUTE THRU UPPER TWIN RESERVOIR

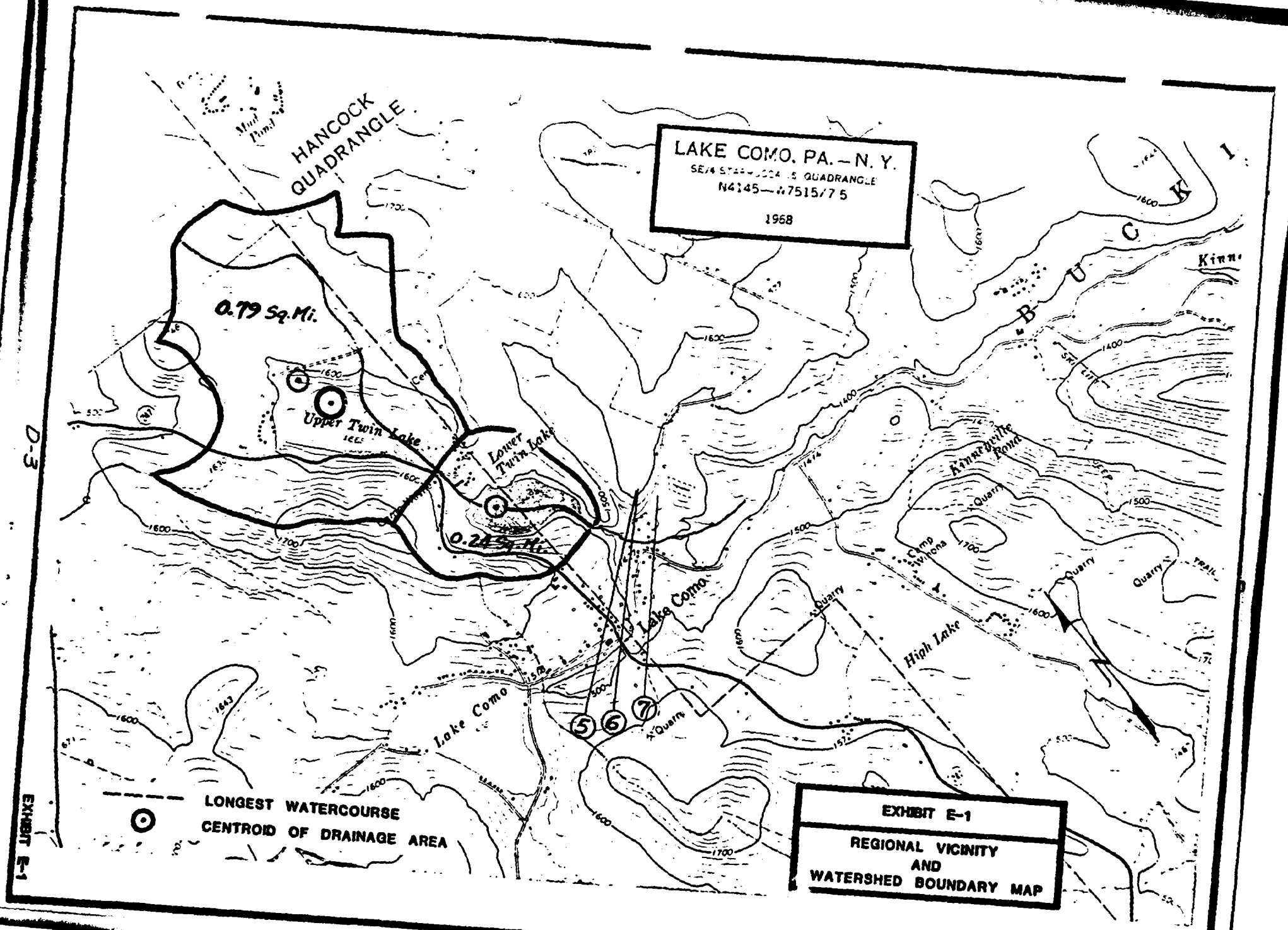
3.) ROUTE TO INLET OF LOWER TWIN RESERVOIR

4.) DEVELOP INFLOW HYDROGRAPH TO LOWER TWIN LAKE OF ADDITIONAL DRAINAGE AREA.

5.) COMBINE HYDROGRAPHS

6.) ROUTE THRU LOWER TWIN RESERVOIR

7.) ROUTE TO DOWNSTREAM SECTIONS


HANCOCK QUADRANGLE
LAKE COMO, PA.–N. Y.
SE/4 STANDARD QUADRANGLE
N4145—W7515/7.5
1968
0.79 Sq.Mi.
0.24 Sq.Mi.
Upper Twin Lake
Lower Twin Lake
Lake Como
Lake Como
High Lake
Kinnyville Road
Camp Winona
Quarry
Quarry
Quarry
Quarry
Quarry
TRAIL
5
6
7
LONGEST WATERCOURSE
CENTROID OF DRAINAGE AREA
EXHIBIT E-1
REGIONAL VICINITY
AND
WATERSHED BOUNDARY MAP
EXHIBIT E-1
D-3

GENERAL DATA

RIVER BASIN	DELAWARE (SUB-BASIN 1) *
STREAM NAME	BRANCH OF KINNEYVILLE CREEK
DAM NAME	LOWER TWIN LAKE DAM
NDI ID No.	PA-00132
DER ID No.	DER 64-018
OWNER	CAMP WAYNE
LOCATION	PRESTON TWP., WAYNE Co., PA
	LAT. N 41°51'16"
	LONG. W 75°20'04"
SIZE CATEGORY	SMALL
HAZARD CATEGORY	HIGH
UPSTREAM DAMS	UPPER TWIN LAKE DAM
DOWNSTREAM DAMS	NONE

* PENN-DER WATER RESOURCES BULLETIN No. 5

UPPER TWIN LAKE

DRAINAGE BASIN & UNIT HYDROGRAPH DATA

DRAINAGE AREA 0.79 Sq. Mi.

SNYDER UNIT HYDROGRAPH COEFFICIENTS
AS SUPPLIED BY BALT. DIST. COE (DELAWARE BASIN ZONE 1)

$C_p = 0.45$
$C_t = 1.23$

LAG TIME = $T_p = C_t (L \times L_{ca})^{0.3}$

$L = 1.33$ mi. RESERVOIR OUTLET TO DRAINAGE DIVIDE.
$L_{ca} = 0.53$ mi. RESERVOIR OUTLET TO CENTROID.

$\therefore T_p = 1.23(1.33 \times 0.53)^{0.3} = 1.11$ HRS.

RAINFALL DATA

PER HYDROMETEOROLOGICAL REPORT No. 33

PMF RAINFALL = 21.5" (24 HR & 200 Sq. Mi.)

RAINFALL DISTRIBUTION

6 HR	111 %
12 HR	123 %
24 HR	133 %
48 HR	142 %

UPPER TWIN LAKE (CONT.)

DAM DATA

TOP OF DAM ELEV. (LOW POINT)	1560.8
DAM LENGTH (INC. SPILLWAY)	320'
DAM HEIGHT	6.8'
DAM WIDTH	20'±
"C" VALUE - DAM	2.7
LEVEL DAM	

SPILLWAY DATA

THERE IS NO CONVENTIONAL EMERGENCY SPILLWAY

THE SERVICE SPILLWAY CONSISTS OF A 4.8'H. × 2.3'W CONC. BOX W/ 2' OF STOP LOGS TO RAISE THE WATER SURFACE TO 1556.0. THE CONC. BOX TRANSITIONS TO A 24"ϕ CMP @ THE OUTLET END. COMPUTE RATING CURVE FOR THE OUTLET & INPUT DIRECTLY.

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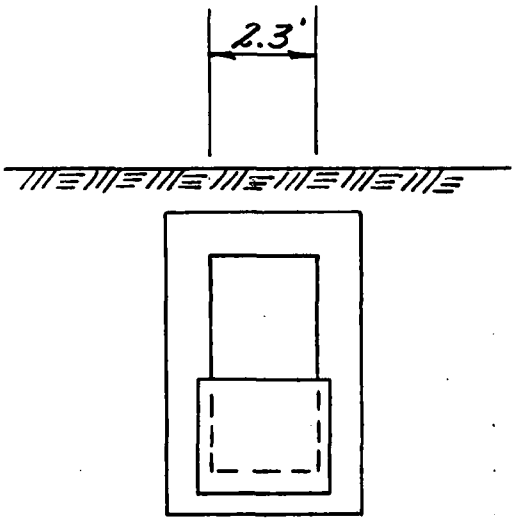
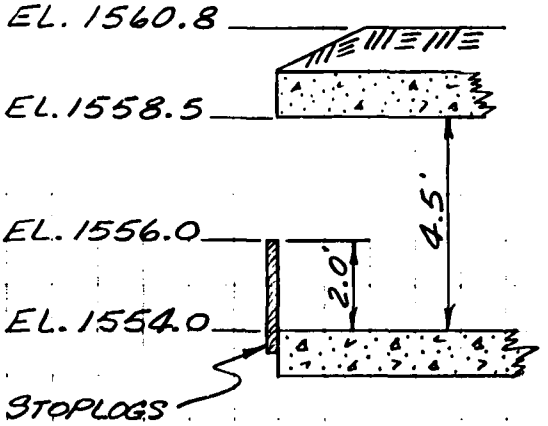
Consulting Engineers & Geologists

[UPPER TWIN LAKE SPILLWAY]



ELEVATION



PROFILE

ASSUME SHARP CRESTED WEIR FLOW UNTIL ENTRANCE IS SUBMERGED

$Q = CLH^{3/2}$

$C = 3.1$

$L = 2.3'$

H = DEPTH OF WATER ABOVE STOPLOGS (W.S. - 1556.0)

AFTER THE ENTRANCE IS SUBMERGED USE ORIFICE FLOW

$Q = Ca\sqrt{2gh}$

$C = 0.7$

$a = 5.75$ S.F.

$g = 32.2$ FT/SEC^2

h = DEPTH OF WATER ABOVE ℄ ORIFICE (W.S. - 1557.25)

JOB LOWER TWIN LAKE PA-00132

SHEET NO ... OF ...

CALCULATED BY WEH DATE 3/9/81

CHECKED BY ... DATE ...

SCALE ...

GEO-TECHNICAL SERVICES
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[UPPER TWIN LAKE SPILLWAY]

W.S. ELEV.	H_1	h	H_2	CFS
1556.0	0	—	—	0
1557.0	1.0	—	—	7
1558.5	2.5	—	—	28
1559.0	—	1.75	—	43
1560.0	—	2.75	—	54
1560.8	—	3.55	0	61
1561.0	—	3.75	0.2	63
1562.0	—	4.75	1.2	70
1563.0	—	5.75	2.2	77
1564.0	—	6.75	3.2	84
1565.0	—	7.75	4.2	90
1566.0	—	8.75	5.2	96

NOTE: SPILLWAY RATING CURVE TO BE INPUT DIRECTLY

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Consulting Engineers & Geologists

JOB UPPER TWIN LAKE

SHEET NO.

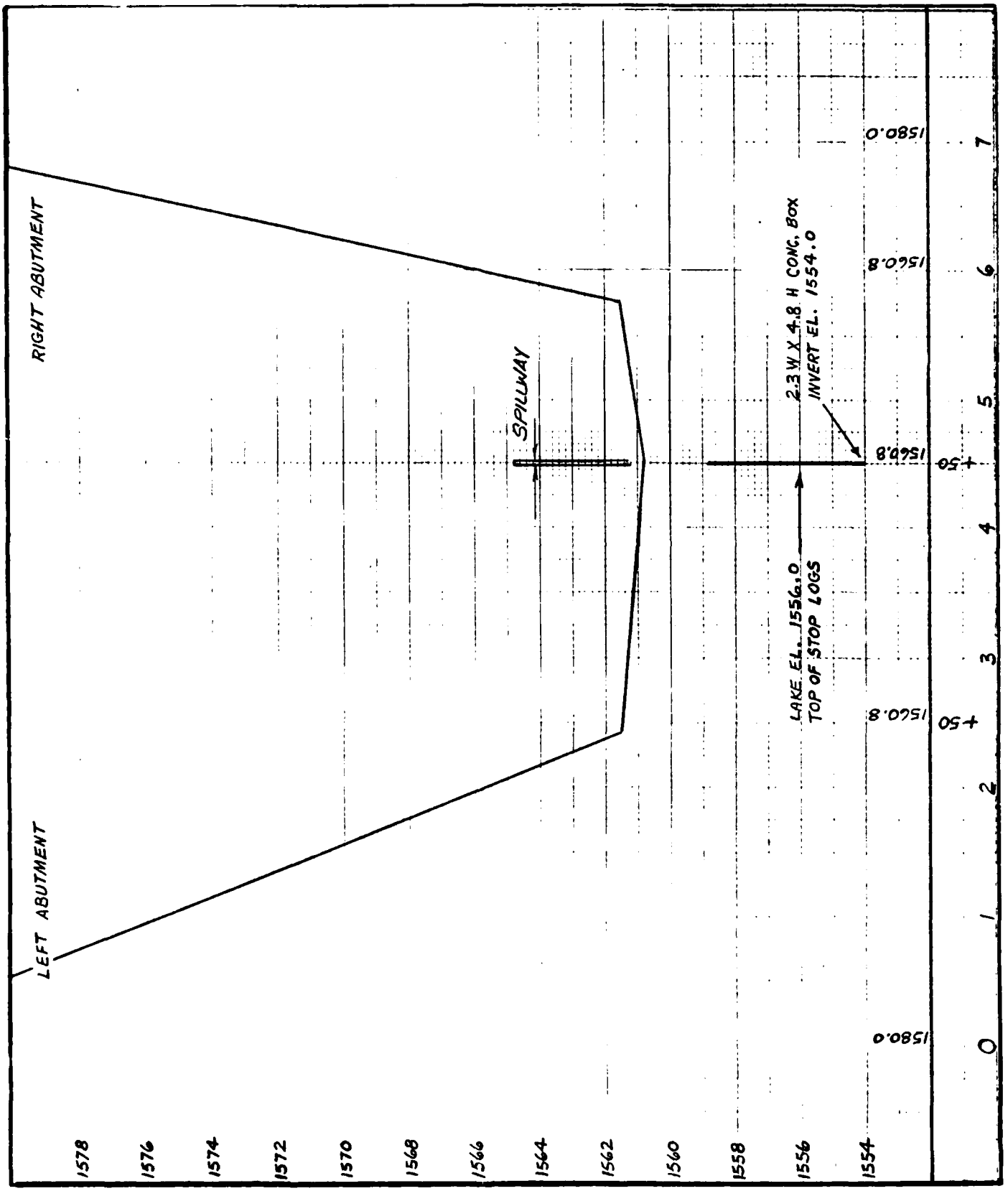
CALCULATED BY

DATE 2-13-81

CHECKED BY

DATE

SCALE



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Consulting Engineers & Geologists

UPPER TWIN LAKE (CONT.)

STORAGE DATA

ELEV (FT.)	AREA (Ac)	STORAGE (MG.)	STORAGE (AC.FT.)	DESCRIPTION
1483.7 (1)	0	0	0	RESERVOIR BOT.
1556	55	433 *	1325	NORMAL POOL
1560.8	74	534	1633	TOP OF DAM
1580	95	1062	3251	CONTOUR

(1) ESTABLISH ELEV. @ 0 AREA

USE STORAGE PER BULLETIN 5 = 433 MG. @ ELEV. 1556

$$\Delta E = {}^{3V}/_{A} = {}^{(3)(1325)}/_{55} = 72.3'$$

ELEV. @ 0 AREA = 1556 - 72.3 = 1483.7

* PENN-DER WATER RESOURCES BULLETIN No. 5

GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

LOWER TWIN LAKE

DRAINAGE BASIN & UNIT HYDROGRAPH DATA

DRAINAGE AREA

DOWNSTR. OF UPPER TWIN LAKE DAM	0.24	SQ. MI.
UPPER TWIN LAKE	0.79	SQ. MI.
TOTAL =	1.03	SQ. MI.

LENGTH OF RESERVOIR - NORMAL 2100 FT.
- MAX 2200 FT.

SNYDER UNIT HYROGRAPH COEFFICIENTS
AS SUPPLIED BY BALT. DIST. COE (DELAWARE BASIN ZONE 1)

$C_p = 0.45$
$C_t = 1.23$

LAG TIME = $T_p = C_t \times (L')^{0.6}$

$L' = 0.20$ MI. FROM RESERVOIR INLET TO DRAINAGE DIVIDE

$\therefore T_p = 1.23 \times 0.20^{0.6} = 0.47$ HRS

RAINFALL DATA

PER HYDROMETEOROLOGICAL REPORT No.33

PMF RAINFALL = 21.5" (24 HR & 200 SQ. MI.)

RAINFALL DISTRIBUTION

6HR	111%
12 HR	123%
24 HR	133%
48 HR	142%

LOWER TWIN LAKE CONT.

DAM DATA

TOP OF DAM ELEV. (LOW POINT)	1496.5
DAM LENGTH	157'
DAM HEIGHT (TOP EARTH FILL)	10.3'
DAM WIDTH	14'
"C" VALUE - DAM	2.7

NON-LEVEL DAM

LENGTH OF DAM	BELOW ELEV.
0'	1496.5
11'	1496.9
14'	1498.0
57'	1500.0
164'	1500.8
179'	1502.0
230'	1506.0

SPILLWAY DATA

THERE IS NO SPILLWAY OF ANY KIND. THE TOTAL OUTFLOW PASSES THRU THE DRY STONE MASONRY DAM, OR POSSIBLY INTO A HIDDEN DRAIN SOMEWHERE BELOW RESERVOIR LEVEL.

GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

OUTLET WORKS DATA

THE ORIGINAL OUTLET WORKS IS NOT VISIBLE @ THE UPSTREAM SIDE & TOTALLY INOPERABLE.

STORAGE DATA

ELEV. (FT.)	AREA (Ac)	STORAGE (MG.)	STORAGE (Ac.FT.)	DESCRIPTION
1463.3 (1)	0	0	0	RESERVOIR BOT.
1495.0	26	90*	275	
1496.5	28.4	103	316	TOP OF DAM (Breach)
1500	34	139	425	CONTOUR
1520	53	421	1288	CONTOUR

(1) ESTABLISH ELEV. @ 0 AREA

USE STORAGE PER BULLETIN 5 OF 90 MG. @ ELEV. 1495

$\Delta E = {}^{3S}/_{A} = {}^{(3)(275)}/_{26} = 31.7'$

ELEV. @ 0 AREA = 1495 - 31.7 = 1463.3

* PENN-DER WATER RESOURCES BULLETIN No.5

GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

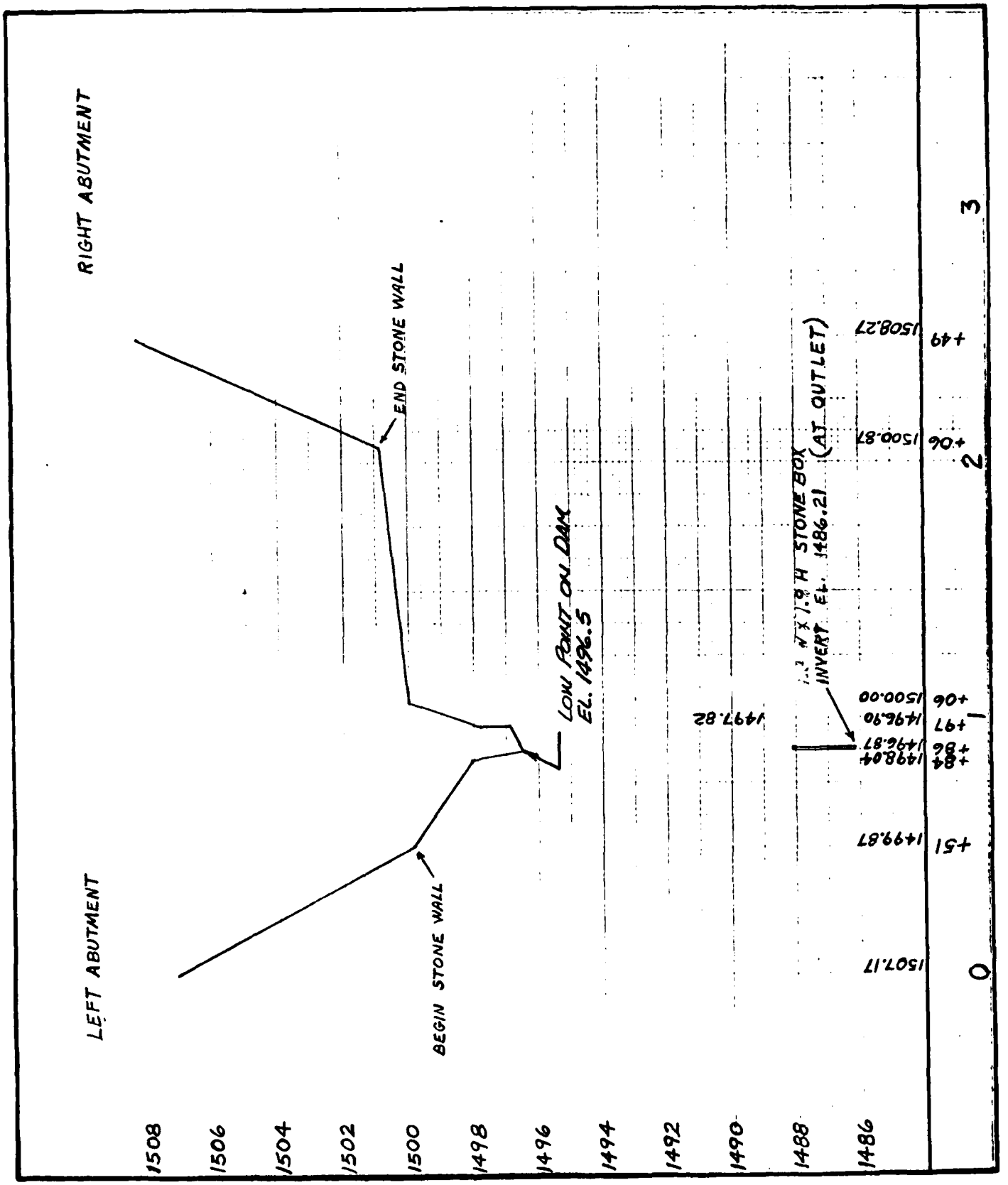
JOB LOWER TWIN LAKE DER 64-18

SHEET NO. ____ OF ____

CALCULATED BY RJM DATE 1-23-81

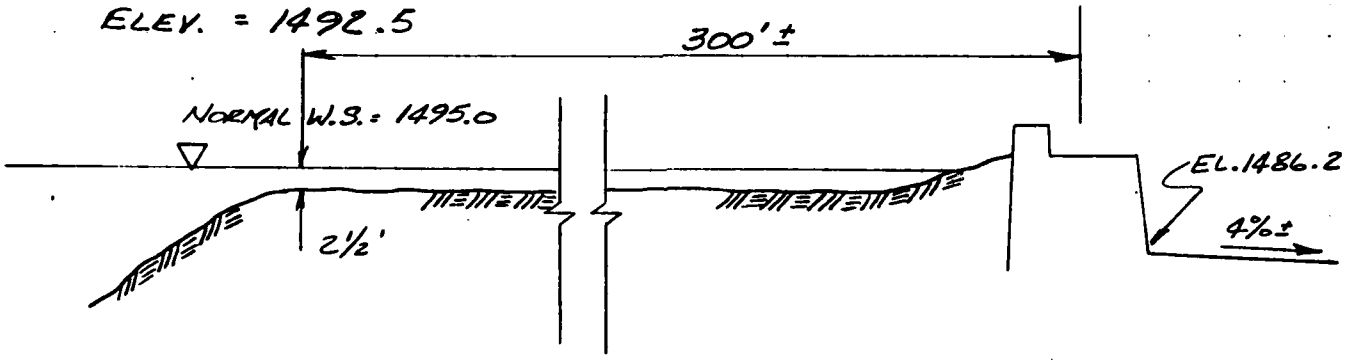
CHECKED BY ____ DATE ____

SCALE HORZ. 1" = 50' VERT. 1" = 4'



DUE TO THE DOWNSTREAM HAZARD CONDITIONS & THE RESULTS OF THE OVERTOPPING ANALYSIS, A BREACH ANALYSIS WILL BE MADE ON LOWER TWIN LAKE DAM. UPPER TWIN LAKE DAM DOES NOT HAVE A POTENTIAL FOR OVERTOPPING FAILURE SERIOUS ENOUGH TO WARRANT FURTHER INVESTIGATION.

THE DAM IS A DRY STONE MASONRY / EARTH FILL STRUCTURE. HOWEVER, FIELD EXAMINATION SHOWS THAT THE DAM HAS BEEN PARTIALLY BREACHED BY A PREVIOUS OVERTOPPING, AND IS IN SUCH A WEAKENED STATE THAT ANOTHER OVERTOPPING OF 1' TO 2' DEPTH WOULD RESULT IN MORE SERIOUS DAMAGE. HOWEVER, THE DAM WAS PLACED AT THE OUTLET OF A NATURAL LAKE, & EVEN IF THE FULL HEIGHT OF DAM WERE TO FAIL, THE RESERVOIR WOULD NOT BE DRAINED BELOW THE ELEV. OF THE NATURAL LAKE OUTLET, SO ASSUME THE BOT. OF THE BREACH TO BE AT THIS ELEV. = 1492.5



ANALYZE THE DAM FOR BREACH WIDTH OF 15', SIDE SLOPES OF 0.5 H on 1 V, BOT. ELEV. = 1492.5, FAILURE TIME OF 15 MIN. & BEGINNING WHEN OVERTOPPING REACHES 1' DEPTH. INVESTIGATE FAILURES OCCURING DURING 0.2 PMF, THE MIN. FLOOD MEETING THE OVERTOPPING CRITERIA, AND 0.5 PMF, THE SELECTED SPILLWAY DESIGN FLOOD.

GEO-TECHNICAL SERVICES
Consulting Engineers & Geologists

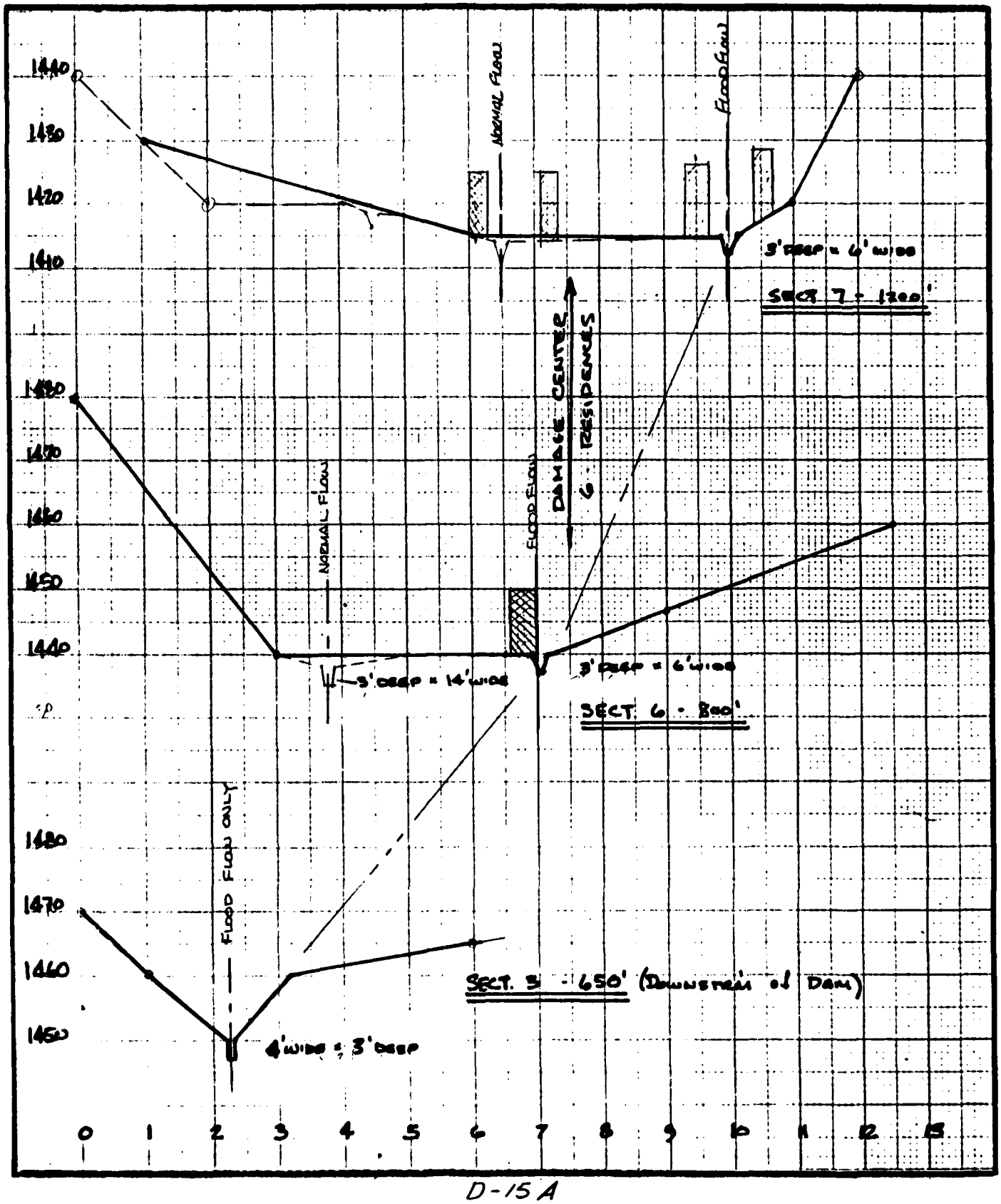
JOB LOWER TWIN LAKE

SHEET NO 1 OF 1

CALCULATED BY sfm DATE 4/81

CHECKED BY _____ DATE _____

X-SECTIONS DOWNSTREAM OF DAM



D-15A

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**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  01 APR 80
**********
    1                A1       NATIONAL DAM INSPECTION PROGRAM
    2                A2       LOWER TWIN LAKE--PA00132 (OVERTOPPING ANALYSIS)
    3                A3       PRESTON TWP. WAYNE CO. PA
    4                B     150        0       15        0        0        0        0        0       -4        0
    5                B1      5        0        0        0        0        0        0        0        0        0
    6                J       1        7        1        0        0        0        0        0        0        0
    7                J1     .1       .2       .3       .4       .5      .75        1        0        0        0
    8                K       0        1        0        0        0        0        1        0        0        0
    9                K1       INFLOW TO UPPER TWIN LAKE (SUB-AREA 1)
   10                M       1        1     0.79        0     1.03        0        0        0        1        0
   11                P       0     21.5      111      123      133      142        0        0        0        0
   12                T       0        0        0        0        0        0        1      .05        0        0
   13                W    1.11     0.45        0        0        0        0        0        0        0        0
   14                X    -1.5     -.05        2        0        0        0        0        0        0        0
   15                K       1        2        0        0        0        0        1        0        0        0
   16                K1       ROUTE THRU UPPER TWIN LAKE
   17                Y       0        0        0        1        1        0        0        0        0        0
   18                Y1      1        0        0        0        0        0    -1556       -1        0        0
   19                Y41556.0  1557.0  1558.5  1559.0  1560.0  1560.8  1561.0  1562.0  1563.0  1564.0
   20                Y41565.0  1566.0        0        0        0        0        0        0        0        0
   21                Y5      0        7       28       43       54       61       65       70       77       84
   22                Y5     90       96        0        0        0        0        0        0        0        0
   23                SA      0       55       74       95        0        0        0        0        0        0
   24                SE1483.7  1556  1560.8  1580        0        0        0        0        0        0
   25                SS1556.0        0        0        0        0        0        0        0        0        0
   26                SD1560.8     2.7      1.5      335        0        0        0        0        0        0
   27                SL      0      335      600        0        0        0        0        0        0        0
   28                SV1560.8  1561.5     1578        0        0        0        0        0        0        0
   29                K       1        3        0        0        0        0        1        0        0        0
   30                K1       LOWER TWIN LAKE STA 3
   31                Y       0        0        0        0        0        0        0        0        0        0
   32                Y1      1        0        0        0        0        0        0        0        0        0
   33                K       0        3        0        0        0        0        1        0        0        0
   34                K1       LOWER TWIN LAKE (SUB-AREA 2)
   35                M       1        1     0.24        0     1.03        0        0        0        1        0
   36                P       0     21.5      111      123      133      142        0        0        0        0
   37                T       0        0        0        0        0        0        1      .05        0        0
   38                W    0.47     0.45        0        0        0        0        0        0        0        0
   39                X    -1.5     -.05        2        0        0        0        0        0        0        0
   40                K       2        3        0        0        0        0        1        0        0        0
   41                K1       INFLOW TO LOWER TWIN LAKE
   42                K       1        4        0        0        0        0        1        0        0        0
   43                K1       ROUTE THRU LOWER TWIN LAKE
   44                Y       0        0        0        1        1        0        0        0        0        0
   45                Y1      1        0        0        0        0        0  -1496.5        0        0        0
   46                SA      0       26     28.4       34       53        0        0        0        0        0
   47                SE1463.5  1495  1496.5  1500  1520        0        0        0        0        0
   48                SS1496.5        0      2.7      1.5        0        0        0        0        0        0
   49                SD1496.5     2.7      1.5      157        0        0        0        0        0        0
   50                SL      0       11       14       57      164      179      230        0        0        0
```

NOTE: LOWER TWIN DAM HAS NO OUTLET FACILITIES. SPILLWAY VALUES REFER TO LOW POINT ON EXISTING BREACH.

```
51              SV1496.5  1496.9    1498     1500  1500.8     1502     1506        0        0        0
52              K       1       5       0        0       0        0        1        0        0        0
53              K1        ROUTE TO STREAM SECTION AT STA 5
54              Y       0       0       0        1       1        0        0        0        0        0
55              Y1      1       0       0        0       0        0        0        0        0        0
56              Y6    .08     .04     .08     1447    1470      650   0.0646        0        0        0
57              Y7      0    1470     100     1460     220     1450      221     1447      225     1447
58              Y7    226    1450     320     1460     600     1465        0        0        0        0
59              K       1       6       0        0       0        0        1        0        0        0
60              K1        ROUTE TO STREAM SECTION AT STA 6
61              Y       0       0       0        1       1        0        0        0        0        0
62              Y1      1       0       0        0       0        0        0        0        0        0
63              Y6    .08     .04     .08     1437    1480      150   0.0667        0        0        0
64              Y7      0    1480     300     1440     695     1440      696     1437      702     1437
65              Y7    703    1440     900     1447    1250     1460        0        0        0        0
66              K       1       7       0        0       0        0        1        0        0        0
67              K1        ROUTE TO STREAM SECTION AT STA 7
68              Y       0       0       0        1       1        0        0        0        0        0
69              Y1      1       0       0        0       0        0        0        0        0        0
70              Y6    .08     .04     .08     1412    1440      400   0.0650        0        0        0
71              Y7      0    1430     605     1415     990     1415      992     1412      998     1412
72              Y7   1010    1415    1100     1420    1200     1440        0        0        0        0
73              K      99       0       0        0       0        0        0        0        0        0
```

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**********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  01 APR 80
**********************************

RUN  DATE= 81/05/05.
     TIME= 06.49.52.
```

NATIONAL DAM INSPECTION PROGRAM
LOWER TWIN LAKE--PA00132 (OVERTOPPING ANALYSIS)
PRESTON TWP., WAYNE CO., PA

JOB SPECIFICATION

NO	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
150	0	15	0	0	0	0	0	-4	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 7 LRTIO= 1

RTIOS= .10 .20 .30 .40 .50 .75 1.00

****

SUB-AREA RUNOFF COMPUTATION

INFLOW TO UPPER TWIN LAKE (SUB-AREA 1)

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	.79	0.00	1.03	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	21.50	111.00	123.00	133.00	142.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA
TP= 1.11 CP= .45 NTA= 0

RECESSION DATA
STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 41 END-OF-PERIOD ORDINATES, LAG= 1.11 HOURS, CP= .45 VOL= 1.00

19.	69.	134.	187.	203.	187.	162.	141.	123.	107.
93.	80.	70.	61.	53.	46.	40.	35.	30.	26.
23.	20.	17.	15.	13.	11.	10.	9.	7.	6.

6. 5. 4. 4. 3. 3. 2. 2. 2. 2.
1.

0 END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	24.42	22.04	2.39	43874.
										(620.)(560.)(61.)(1242.37)			

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HYDROGRAPH ROUTING

ROUTE THRU UPPER TWIN LAKE

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTOL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-1556.	-1

STAGE	1556.00	1557.00	1558.50	1559.00	1560.00	1560.80	1561.00	1562.00	1563.00	1564.00	1565.00	1566.00
FLOW	0.00	7.00	28.00	43.00	54.00	61.00	63.00	70.00	77.00	84.00	90.00	96.00

SURFACE AREA=	0.	55.	74.	95.
CAPACITY=	0.	1326.	1634.	3252.
ELEVATION=	1484.	1556.	1561.	1580.

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
1556.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
1560.8	2.7	1.5	335.

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CREST LENGTH	0.	535.	600.
AT OR BELOW ELEVATION	1560.8	1561.5	1578.0

PEAK OUTFLOW IS 13. AT TIME 48.00 HOURS

PEAK OUTFLOW IS 34. AT TIME 47.25 HOURS

PEAK OUTFLOW IS 52. AT TIME 47.25 HOURS

PEAK OUTFLOW IS 69. AT TIME 47.25 HOURS

PEAK OUTFLOW IS 302. AT TIME 44.25 HOURS

PEAK OUTFLOW IS 1058. AT TIME 42.75 HOURS

PEAK OUTFLOW IS 1696. AT TIME 42.00 HOURS

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HYDROGRAPH ROUTING

LOWER TWIN LAKE STA 3

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
3	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPHP	LSTR
0.0	0.000	0.00	0	0	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

SUB-AREA RUNOFF COMPUTATION

LOWER TWIN LAKE (SUB-AREA 2)

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
3	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	.24	0.00	1.03	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	21.50	111.00	123.00	133.00	142.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
3	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA

TP= .47 CP= .45 NTA= 0

RECESSION DATA

STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 16 END-OF-PERIOD ORDINATES, LAG= .47 HOURS, CP= .45 VOL= 1.00

52. 132. 136. 93. 64. 44. 30. 21. 14. 10.

7. 5. 3. 2. 2. 1.

0

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	24.42	22.04	2.39	13655.
										(620.)	(560.)	(61.)	(386.67)

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COMBINE HYDROGRAPHS

INFLOW TO LOWER TWIN LAKE

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
3	2	0	0	0	0	1	0	0

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HYDROGRAPH ROUTING

ROUTE THRU LOWER TWIN LAKE

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
4	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-1497.	0

SURFACE AREA=	0.	26.	28.	34.	53.
CAPACITY=	0.	275.	316.	425.	1288.
ELEVATION=	1463.	1495.	1497.	1500.	1520.

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
1496.5	0.0	2.7	1.5	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
1496.5	2.7	1.5	157.

CREST LENGTH	0.	11.	14.	57.	164.	179.	230.
AT OR BELOW ELEVATION	1496.5	1496.9	1498.0	1500.0	1500.8	1502.0	1506.0

PEAK OUTFLOW IS 19. AT TIME 43.50 HOURS

PEAK OUTFLOW IS 57. AT TIME 42.75 HOURS

PEAK OUTFLOW IS 110. AT TIME 42.75 HOURS

PEAK OUTFLOW IS 173. AT TIME 42.50 HOURS

PEAK OUTFLOW IS 277. AT TIME 45.25 HOURS

PEAK OUTFLOW IS 1138. AT TIME 43.00 HOURS

PEAK OUTFLOW IS 2011. AT TIME 42.25 HOURS

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HYDROGRAPH ROUTING

ROUTE TO STREAM SECTION AT STA 5

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
5	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.0800	.0400	.0800	1447.0	1470.0	650.	.06460

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

0.00 1470.00 100.00 1460.00 220.00 1450.00 221.00 1447.00 225.00 1447.00
226.00 1450.00 320.00 1460.00 600.00 1465.00

STORAGE	0.00	.08	.17	.34	.93	1.98	3.51	5.50	7.96	10.88
	14.28	18.17	23.24	29.76	37.72	47.11	57.18	67.47	77.98	88.71
OUTFLOW	0.00	43.98	129.78	274.51	619.41	1312.65	2477.07	4219.55	6637.27	9820.55
	13854.54	18268.78	23231.99	30442.87	39878.71	52052.30	68851.00	87962.89	109316.08	132859.35
STAGE	1447.00	1448.21	1449.42	1450.63	1451.84	1453.05	1454.26	1455.47	1456.68	1457.89
	1459.11	1460.32	1461.53	1462.74	1463.95	1465.16	1466.37	1467.58	1468.79	1470.00
FLOW	0.00	43.98	129.78	274.51	619.41	1312.65	2477.07	4219.55	6637.27	9820.55
	13854.54	18268.78	23231.99	30442.87	39878.71	52052.30	68851.00	87962.89	109316.08	132859.35

MAXIMUM STAGE IS 1447.5

MAXIMUM STAGE IS 1448.4

MAXIMUM STAGE IS 1449.1

MAXIMUM STAGE IS 1449.8

MAXIMUM STAGE IS 1450.6

MAXIMUM STAGE IS 1452.7

MAXIMUM STAGE IS 1453.8

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HYDROGRAPH ROUTING

ROUTE TO STREAM SECTION AT STA 6

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
6	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.0800	.0400	.0800	1437.0	1480.0	150.	.06670

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

0.00 1480.00 300.00 1440.00 695.00 1440.00 696.00 1437.00 702.00 1437.00
705.00 1440.00 900.00 1447.00 1250.00 1460.00

STORAGE	0.00	.05	2.33	6.21	10.72	15.85	21.59	27.94	34.90	42.46
	50.63	59.24	67.99	76.87	85.89	95.03	104.31	113.72	123.27	132.94
OUTFLOW	0.00	185.72	4613.09	20480.66	46265.25	81943.61	127741.67	184002.13	251162.09	329689.58
	420068.27	530413.66	654306.26	789880.67	936855.60	1095010.02	1264167.77	1444187.35	1634954.61	1836377.47
STAGE	1437.00	1439.26	1441.53	1443.79	1446.05	1448.32	1450.58	1452.84	1455.11	1457.37
	1459.63	1461.89	1464.16	1466.42	1468.68	1470.95	1473.21	1475.47	1477.74	1480.00
FLOW	0.00	185.72	4613.09	20480.66	46265.25	81943.61	127741.67	184002.13	251162.09	329689.58
	420068.27	530413.66	654306.26	789880.67	936855.60	1095010.02	1264167.77	1444187.35	1634954.61	1836377.47

MAXIMUM STAGE IS 1437.2

MAXIMUM STAGE IS 1437.7

MAXIMUM STAGE IS 1438.3

MAXIMUM STAGE IS 1439.1

MAXIMUM STAGE IS 1439.3

MAXIMUM STAGE IS 1439.8

MAXIMUM STAGE IS 1440.2

HYDROGRAPH ROUTING

ROUTE TO STREAM SECTION AT STA 7

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
7	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTOL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

GN(1)	GN(2)	GN(3)	ELNVT	ELMAX	RLNTH	SEL
.0800	.0400	.0800	1412.0	1440.0	400.	.06500

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
0.00 1430.00 605.00 1415.00 990.00 1415.00 992.00 1412.00 998.00 1412.00
1010.00 1415.00 1100.00 1420.00 1200.00 1440.00

STORAGE	0.00	.13	.35	6.18	13.37	21.72	31.18	41.58	52.88	65.08
	78.19	92.21	107.12	122.69	138.39	154.18	170.07	186.05	202.14	218.33
OUTFLOW	0.00	132.49	523.33	4794.54	14330.47	28624.92	47903.78	72197.54	101478.53	135888.18
	175593.16	220773.72	271617.60	335679.43	407636.52	485306.38	568534.00	657186.68	751149.44	850321.62
STAGE	1412.00	1413.47	1414.95	1416.42	1417.89	1419.37	1420.84	1422.32	1423.79	1425.26
	1426.74	1428.21	1429.68	1431.16	1432.63	1434.11	1435.58	1437.05	1438.53	1440.00
FLOW	0.00	132.49	523.33	4794.54	14330.47	28624.92	47903.78	72197.54	101478.53	135888.18
	175593.16	220773.72	271617.60	335679.43	407636.52	485306.38	568534.00	657186.68	751149.44	850321.62

MAXIMUM STAGE IS 1412.2

MAXIMUM STAGE IS 1412.6

MAXIMUM STAGE IS 1413.2

MAXIMUM STAGE IS 1413.6

MAXIMUM STAGE IS 1414.0

MAXIMUM STAGE IS 1415.2

MAXIMUM STAGE IS 1415.5

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PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 .10	RATIO 2 .20	RATIO 3 .30	RATIO 4 .40	RATIO 5 .50	RATIO 6 .75	RATIO 7 1.00
HYDROGRAPH AT	1	.79	1	210.	420.	629.	839.	1049.	1573.	2098.
		(2.05)	(	5.94)(	11.88)(	17.82)(	23.76)(	29.70)(	44.55)(	59.40)(
ROUTED TO	2	.79	1	13.	34.	52.	69.	302.	1058.	1696.
		(2.05)	(	.37)(	.96)(	1.48)(	1.96)(	8.56)(	29.97)(	48.01)(
ROUTED TO	3	.79	1	13.	34.	52.	69.	302.	1058.	1696.
		(2.05)	(	.37)(	.96)(	1.48)(	1.96)(	8.56)(	29.97)(	48.01)(
HYDROGRAPH AT	3	.24	1	99.	198.	297.	396.	495.	742.	989.
		(.62)	(	2.80)(	5.60)(	8.40)(	11.20)(	14.01)(	21.01)(	28.01)(
2 COMBINED	3	1.03	1	103.	206.	312.	418.	524.	1256.	2096.
		(2.67)	(	2.91)(	5.83)(	8.84)(	11.83)(	14.85)(	35.56)(	59.37)(
ROUTED TO	4	1.03	1	19.	57.	110.	173.	277.	1138.	2011.
		(2.67)	(	.54)(	1.62)(	3.10)(	4.91)(	7.83)(	32.23)(	56.96)(
ROUTED TO	5	1.03	1	19.	57.	110.	173.	277.	1138.	2010.
		(2.67)	(	.54)(	1.62)(	3.10)(	4.91)(	7.83)(	32.24)(	56.92)(
ROUTED TO	6	1.03	1	19.	57.	110.	173.	277.	1139.	2010.
		(2.67)	(	.54)(	1.62)(	3.10)(	4.91)(	7.83)(	32.24)(	56.92)(
ROUTED TO	7	1.03	1	19.	57.	110.	173.	277.	1138.	2010.
		(2.67)	(	.54)(	1.62)(	3.10)(	4.91)(	7.84)(	32.23)(	56.91)(

SUMMARY OF DAM SAFETY ANALYSIS (UPPER TWIN LAKE)

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1556.00	1556.00	1560.80
STORAGE	1326.	1326.	1634.
OUTFLOW	0.	0.	61.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	1557.43	0.00	1408.	13.	0.00	48.00	0.00
.20	1558.69	0.00	1487.	34.	0.00	47.25	0.00
.30	1559.85	0.00	1565.	52.	0.00	47.25	0.00
.40	1560.97	.17	1647.	69.	3.50	47.25	0.00
.50	1561.51	.71	1687.	302.	5.75	44.25	0.00
.75	1562.12	1.32	1732.	1058.	7.25	42.75	0.00
1.00	1562.49	1.69	1760.	1696.	7.75	42.00	0.00

SUMMARY OF DAM SAFETY ANALYSIS (LOWER TWIN LAKE)

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1496.50	1496.50	1496.50
STORAGE	316.	316.	316.
OUTFLOW	0.	0.	0.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	1497.37	.87	341.	19.	48.00	43.50	0.00
.20	1498.04	1.54	361.	57.	48.00	42.75	0.00
.30	1498.62	2.12	379.	110.	48.00	42.75	0.00
.40	1499.08	2.58	394.	173.	48.00	42.50	0.00
.50	1499.60	3.10	411.	277.	48.00	45.25	0.00
.75	1501.28	4.78	469.	1138.	48.00	43.00	0.00
1.00	1502.11	5.61	498.	2011.	48.00	42.25	0.00

PLAN 1 STATION 5

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.10	19.	1447.5	43.50
.20	57.	1448.4	43.00
.30	110.	1449.1	42.75
.40	173.	1449.8	42.50
.50	277.	1450.6	45.50
.75	1138.	1452.7	43.00
1.00	2010.	1453.8	42.25

PLAN 1 STATION 6

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.10	19.	1437.2	43.50
.20	57.	1437.7	43.00
.30	110.	1438.3	42.75
.40	173.	1439.1	42.50
.50	277.	1439.3	45.50
.75	1139.	1439.8	43.00
1.00	2010.	1440.2	42.25

PLAN 1 STATION 7

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.10	19.	1412.2	43.50
.20	57.	1412.6	43.01
.30	110.	1413.2	42.75
.40	173.	1413.6	42.50
.50	277.	1414.0	45.50
.75	1138.	1415.2	43.00
1.00	2010.	1415.5	42.25

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 81/05/08. 09.53.58.
PROGRAM    TWBK
A1         NATIONAL DAM INSPECTION PROGRAM
A2         LOWER TWIN LAKE--PA00132 (BREACH ANALYSIS)
A3         PRESTON TWP, WAYNE CO, PA
B     150         0        15         0         0         0         0         0         1         0
B1      5         0         0         0         0         0         0         0         0         0
J       1         2         1         0         0         0         0         0         0         0
J1     .2        .5         0         0         0         0         0         0         0         0
K       0         1         0         0         0         0         1         0         0         0
K1         INFLOW TO UPPER TWIN LAKE (SUB-AREA 1)
M       1         1      0.79         0      1.03         0         0         0         1         0
P       0      21.5       111       123       133       142         0         0         0         0
T       0         0         0         0         0         0         1       .05         0         0
W    1.11      0.45         0         0         0         0         0         0         0         0
X    -1.5      -.05         2         0         0         0         0         0         0         0
K       1         2         0         0         0         0         1         0         0         0
K1         ROUTE THRU UPPER TWIN LAKE
Y       0         0         0         1         1         0         0         0         0         0
Y1      1         0         0         0         0         0     -1556        -1         0         0
Y41556.0  1557.0  1558.5  1559.0  1560.0  1560.8  1561.0  1562.0  1563.0  1564.0
T41565.0  1566.0         0         0         0         0         0         0         0         0
Y5      0         7        28        43        54        61        63        70        77        84
Y5     90        96         0         0         0         0         0         0         0         0
$A      0        55        74        95         0         0         0         0         0         0
$E1483.7     1556  1560.8      1580         0         0         0         0         0         0
$$1556.0         0         0         0         0         0         0         0         0         0
$D1560.8       2.7       1.5       335         0         0         0         0         0         0
$L      0       335       600         0         0         0         0         0         0         0
$V1560.8  1561.5      1578         0         0         0         0         0         0         0
K       1         3         0         0         0         0         1         0         0         0
K1         LOWER TWIN LAKE STA 3
Y       0         0         0         0         0         0         0         0         0         0
Y1      1         0         0         0         0         0         0         0         0         0
K       0         3         0         0         0         0         1         0         0         0
K1         LOWER TWIN LAKE (SUB-AREA 2)
M       1         1      0.24         0      1.03         0         0         0         1         0
P       0      21.5       111       123       133       142         0         0         0         0
T       0         0         0         0         0         0         1       .05         0         0
W    0.47      0.45         0         0         0         0         0         0         0         0
X    -1.5      -.05         2         0         0         0         0         0         0         0
K       2         3         0         0         0         0         1         0         0         0
K1         INFLOW TO LOWER TWIN LAKE
K       1         4         0         0         0         0         1         0         0         0
K1         ROUTE THRU LOWER TWIN LAKE
Y       0         0         0         1         1         0         0         0         0         0
Y1      1         0         0         0         0         0  -1496.5         0         0         0
$A      0        26      28.4        34        53         0         0         0         0         0
$E1463.3     1495  1496.5      1500      1520         0         0         0         0         0
$$1496.5         0       2.7       1.5         0         0         0         0         0         0
$D1496.5       2.7       1.5       157         0         0         0         0         0         0
$L      0        11        14        57       164       179       230         0         0         0
$V1496.5  1496.9      1498      1500  1500.8      1502      1506         0         0         0
$B     15        .5    1492.5       .25    1496.5    1497.5         0         0         0         0
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K       1       5       0       0       0       0       1       0       0       0
K1        ROUTE TO STREAM SECTION AT STA 5
Y       0       0       0       1       1       0       0       0       0       0
Y1      1       0       0       0       0       0       0       0       0       0
Y6    .08     .04     .08    1447    1470     650  0.0646       0       0       0
Y7      0    1470     100    1460     220    1450     221    1447     225    1447
Y7    226    1450     320    1460     600    1465       0       0       0       0
K       1       6       0       0       0       0       1       0       0       0
K1        ROUTE TO STREAM SECTION AT STA 6
Y       0       0       0       1       1       0       0       0       0       0
Y1      1       0       0       0       0       0       0       0       0       0
Y6    .08     .04     .08    1437    1480     150  0.0667       0       0       0
Y7      0    1480     300    1440     695    1440     696    1437     702    1437
Y7    703    1440     900    1447    1250    1460       0       0       0       0
K       1       7       0       0       0       0       1       0       0       0
K1        ROUTE TO STREAM SECTION AT STA 7
Y       0       0       0       1       1       0       0       0       0       0
Y1      1       0       0       0       0       0       0       0       0       0
Y6    .08     .04     .08    1412    1440     400  0.0650       0       0       0
Y7      0    1430     605    1415     990    1415     992    1412     998    1412
Y7   1010    1415    1100    1420    1200    1440       0       0       0       0
K      99       0       0       0       0       0       0       0       0       0
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RUN DATE= 81/05/15.
TIME= 13.22.29.

NATIONAL DAM INSPECTION PROGRAM
LOWER TWIN LAKE--PA00132 (PREACH ANALYSIS)
PRESTON TWP, WAYNE CO, PA

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
150	0	15	0	0	0	0	0	1	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 2 LRTIO= 1

RTIOS= .20 .50

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SUB-AREA RUNOFF COMPUTATION

INFLOW TO UPPER TWIN LAKE (SUB-AREA 1)

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	.79	0.00	1.03	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	21.50	111.00	123.00	133.00	142.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA
TP= 1.11 CP= .45 NTA= 0

RECESSION DATA
STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC= 4.68 AND R= 7.13 INTERVALS

UNIT HYDROGRAPH 41 END-OF-PERIOD ORDINATES, LAG= 1.11 HOURS, CP= .45 VOL= 1.00

19.	69.	134.	187.	203.	187.	162.	141.	123.	107.
93.	80.	70.	61.	53.	46.	40.	35.	30.	26.

23.	20.	17.	15.	13.	11.	10.	9.	7.	6.
6.	5.	4.	4.	3.	3.	2.	2.	2.	2.
1.									

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	END-OF-PERIOD FLOW COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
								SUM		24.42	22.04	2.39	43874.
										(620.)	(560.)	(61.)	(1242.37)

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HYDROGRAPH ROUTING

ROUTE THRU UPPER TWIN LAKE

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ROUTING DATA

OLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-1556.	-1

STAGE	1556.00	1557.00	1558.50	1559.00	1560.00	1560.80	1561.00	1562.00	1563.00	1564.00
	1565.00	1566.00								
FLOW	0.00	7.00	26.00	43.00	54.00	61.00	63.00	70.00	77.00	84.00
	90.00	96.00								
SURFACE AREA=	0.	55.	74.	95.						
CAPACITY=	0.	1526.	1634.	3252.						
ELEVATION=	1484.	1556.	1561.	1580.						

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
1556.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COCD	EXPD	DAMWID
1560.8	2.7	1.5	335.

CREST LENGTH	0.	335.	600.
AT OR BELOW ELEVATION	1560.8	1561.5	1578.0

PEAK OUTFLOW IS 302. AT TIME 44.25 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	302.	198.	56.	28.	5412.
CMS	9.	6.	2.	1.	153.
INCHES		2.34	2.65	2.66	2.66
MM		59.36	67.19	67.45	67.45
AC-FT		98.	111.	112.	112.
THOUS CU M		121.	137.	138.	138.

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HYDROGRAPH ROUTING

LOWER TWIN LAKE STA 3

ISTAG	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
3	1	0	0	0	0	1	0	0

ROUTING DATA

GLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	0	0	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	SIGRA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

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SUB-AREA RUNOFF COMPUTATION

LOWER TWIN LAKE (SUB-AREA 2)

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
3	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	.24	0.00	1.03	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	21.50	111.00	123.00	133.00	142.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA

TP= .47 CP= .45 NTA= 0

RECESSION DATA

STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC= 1.90 AND R= 2.71 INTERVALS

UNIT HYDROGRAPH 16 END-OF-PERIOD ORDINATES, LAG= .47 HOURS, CP= .45 VOL= 1.00

52.	132.	136.	93.	64.	44.	30.	21.	14.	10.
7.	5.	3.	2.	2.	1.				

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HYDROGRAPH ROUTING

ROUTE THRU LOWER TWIN LAKE

ISTAO	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
4	1	0	0	0	0	1	0	0

ROUTING DATA

GLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	2	0	0.000	0.000	0.000	-1497.	0

SURFACE AREA=	0.	2.	28.	34.	53.
CAPACITY=	0.	275.	316.	425.	1288.
ELEVATION=	1493.	1495.	1497.	1500.	1520.

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
1496.5	0.0	2.7	1.5	0.0	0.0	0.0	0.0

DAM DATA

ICFEL	COQD	EXPD	DAMWID
1496.5	2.7	1.5	157.

CREST LENGTH	0.	11.	14.	57.	164.	179.	230.
AT OR BELOW ELEVATION	1496.5	1496.9	1498.0	1500.0	1500.8	1502.0	1506.0

DAM BREACH DATA

BRWID	Z	ELBM	TFAIL	WSEL	FAILEL
15.	.50	1492.50	.25	1496.50	1497.50

STATION 4, PLAN 1, RATIO 1

BEGIN DAM FAILURE AT 40.25 HOURS

PEAK OUTFLOW IS 593. AT TIME 40.50 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	593.	265.	74.	37.	7110.
CMS	17.	7.	2.	1.	201.
INCHES		2.39	2.68	2.68	2.68
MM		60.71	67.95	67.96	67.96
AC-FT		131.	147.	147.	147.
THOUS CU M		162.	181.	181.	181.

•OVN•

STATION 4, PLAN 1, RATIO 2

BEGIN DAM FAILURE AT 3[illegible].00 HOURS

PEAK OUTFLOW IS 584. AT TIME 38.25 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	584.	390.	146.	73.	13993.
CMS	17.	11.	4.	2.	396.
INCHES		3.52	5.27	5.27	5.27
MM		89.46	133.73	133.75	133.75
AC-FT		193.	269.	289.	289.
THOUS CU M		239.	357.	357.	357.

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HYDROGRAPH ROUTING

ROUTE TO STREAM SECTION AT STA 5

ISTAO	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
5	1	0	0	0	0	1	0	0

ROUTING DATA

CLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.0600	.0400	.0600	1447.0	1470.0	650.	.06450

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
0.00 1470.00 100.00 1460.00 220.00 1450.00 221.00 1447.00 225.00 1447.00
226.00 1450.00 320.00 1460.00 600.00 1465.00

STORAGE	0.00	.08	.17	.34	.93	1.98	3.51	5.50	7.96	10.88
	14.28	18.17	23.24	29.76	37.72	47.11	57.18	67.47	77.98	88.71
OUTFLOW	0.00	43.98	129.72	274.51	619.41	1312.65	2477.07	4219.55	6637.27	9820.55
	13824.54	18268.78	23231.99	30442.87	39878.71	52052.30	68851.00	87962.89	109316.08	132859.35
STAGE	1447.00	1448.21	1449.42	1450.63	1451.84	1453.05	1454.26	1455.47	1456.68	1457.89
	1459.11	1460.32	1461.53	1462.74	1463.95	1465.16	1466.37	1467.58	1468.79	1470.00
FLOW	0.00	43.98	129.72	274.51	619.41	1312.65	2477.07	4219.55	6637.27	9820.55
	13824.54	18268.78	23231.99	30442.87	39878.71	52052.30	68851.00	87962.89	109316.08	132859.35

STATION 5, PLAN 1, RTIO 1

MAXIMUM STAGE IS 1451.8

STATION 5, PLAN 1, RTIO 2

MAXIMUM STAGE IS 1451.7

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HYDROGRAPH ROUTING

ROUTE TO STREAM SECTION AT STA 6

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
6	1	0	0	0	0	1	0	0

ROUTING DATA

CLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTOL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

CN(1)	CN(2)	CN(3)	ELMVT	ELMXV	ELMTH	SEL
.0500	.0400	.0500	1437.0	1440.0	150.	.06670

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
0.00 1440.00 300.00 1440.00 695.00 1440.00 696.00 1437.00 702.00 1437.00
703.00 1440.00 900.00 1447.00 1250.00 1460.00

STORAGE	0.00	.05	2.33	6.21	10.72	15.85	21.59	27.94	34.90	42.46
	50.63	59.49	67.99	76.87	85.89	95.03	104.31	113.72	123.27	132.94
OUTFLOW	0.00	185.72	4613.09	20480.66	46265.25	81943.61	127741.67	184002.13	251162.09	329689.58
	420066.27	530413.66	654306.26	789860.67	936855.60	1095010.02	1264167.77	1444187.35	1634954.61	1836377.47
STAGE	1437.00	1439.26	1441.53	1443.79	1446.05	1448.32	1450.58	1452.84	1455.11	1457.37
	1459.63	1461.89	1464.16	1466.42	1468.68	1470.95	1473.21	1475.47	1477.74	1480.00
FLOW	0.00	185.72	4613.09	20480.66	46265.25	81943.61	127741.67	184002.13	251162.09	329689.58
	420066.27	530413.66	654306.26	789860.67	936855.60	1095010.02	1264167.77	1444187.35	1634954.61	1836377.47

STATION 6, PLAN 1, RTIO 1

MAXIMUM STAGE IS 1439.5

STATION 6, PLAN 1, RTIO 2

MAXIMUM STAGE IS 1439.5

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HYDROGRAPH ROUTING

ROUTE TO STREAM SECTION AT STA 7

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
7	1	0	0	0	0	1	0	0

ROUTING DATA

GLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTOL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

GN(1)	GN(2)	GN(3)	ELEVT	ELMAX	RLNTH	SEL
.0800	.0400	.0800	1412.0	1440.0	400.	.06500

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
0.00 1430.00 605.00 1415.00 890.00 1415.00 992.00 1412.00 998.00 1412.00
1010.00 1415.00 1100.00 1420.00 1200.00 1440.00

STORAGE	0.00	.13	.35	6.18	13.37	21.72	31.18	41.58	52.88	65.08
	78.19	92.21	107.12	122.69	138.39	154.18	170.07	186.05	202.14	218.33
OUTFLOW	0.00	132.49	523.33	4794.54	14330.47	28624.92	47903.78	72197.54	101478.53	135888.18
	175593.16	220773.72	271617.60	328079.43	407636.59	485306.38	568534.00	657186.68	751149.44	850321.62
STAGE	1412.00	1413.47	1414.95	1416.42	1417.89	1419.37	1420.84	1422.32	1423.79	1425.26
	1426.74	1428.21	1429.68	1431.16	1432.63	1434.11	1435.58	1437.05	1438.53	1440.00
FLOW	0.00	132.49	523.33	4794.54	14330.47	28624.92	47903.78	72197.54	101478.53	135888.18
	175593.16	220773.72	271617.60	328079.43	407636.59	485306.38	568534.00	657186.68	751149.44	850321.62

STATION 7, PLAN 1, RTIO 1

MAXIMUM STAGE IS 1415.0

STATION 7, PLAN 1, RTIO 2

MAXIMUM STAGE IS 1415.0

********** ********** ********** ********** **********

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIO APPLIED TO FLOWS RATIO 1 .20	RATIO 2 .50
HYDROGRAPH AT	1	.79	1	423.	1049.
		(2.05)		(11.98)(	29.70)(
ROUTED TO	2	.79	1	34.	302.
		(2.05)		(.96)(	8.56)(
ROUTED TO	3	.79	1	34.	302.
		(2.05)		(.96)(	8.56)(
HYDROGRAPH AT	3	.24	1	198.	495.
		(.62)		(5.60)(	14.01)(
2 COMBINED	3	1.03	1	206.	524.
		(2.67)		(5.83)(	14.85)(
ROUTED TO	4	1.03	1	593.	584.
		(2.67)		(16.78)(	16.53)(
ROUTED TO	5	1.03	1	597.	591.
		(2.67)		(16.91)(	16.73)(
ROUTED TO	6	1.03	1	612.	605.
		(2.67)		(17.33)(	17.14)(
ROUTED TO	7	1.03	1	624.	618.
		(2.67)		(17.68)(	17.50)(

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SUMMARY OF DAM SAFETY ANALYSIS [UPPER TWIN]

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1556.00	1556.00	1560.80
STORAGE	1326.	1326.	1634.
OUTFLOW	0.	0.	61.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.20	1558.69	0.00	1487.	34.	0.00	47.25	0.00
.50	1561.51	.71	1687.	302.	5.75	44.25	0.00

SUMMARY OF DAM SAFETY ANALYSIS LOWER TWIN

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1496.50	1496.50	1496.50
STORAGE	316.	316.	316.
OUTFLOW	0.	0.	0.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.20	1497.60	1.10	348.	593.	41.50	40.50	40.25
.50	1497.55	1.05	346.	584.	40.75	38.25	38.00

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PLAN 1 STATION 5

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.20	597.	1451.8	40.75
.50	591.	1451.7	38.50

PLAN 1 STATION 6

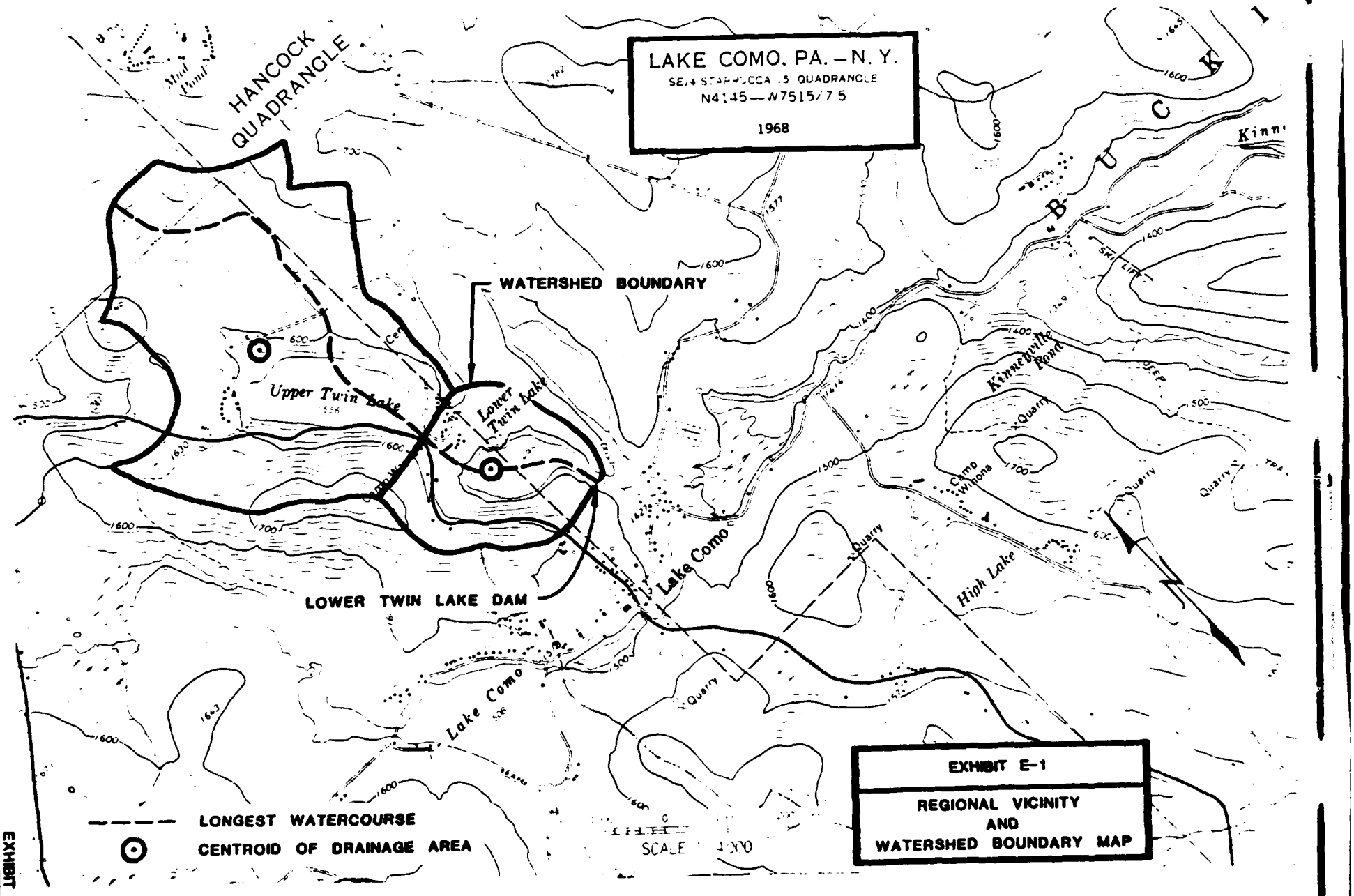
RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.20	612.	1439.5	40.75
.50	605.	1439.5	38.50

PLAN 1 STATION 7

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.20	624.	1415.0	40.75
.50	618.	1415.0	38.50

APPENDIX E

EXHIBITS


LAKE COMO, PA.–N. Y.
SE/4 STARRUCCA 15 QUADRANGLE
N4145—W7515/7 5
1968
HANCOCK QUADRANGLE
WATERSHED BOUNDARY
Upper Twin Lake
Lower Twin Lake
LOWER TWIN LAKE DAM
Lake Como
Lake Como
Kinnerville Pond
Camp Winona
High Lake
Quarry
Quarry
Quarry
Quarry
Mud Pond
LONGEST WATERCOURSE
CENTROID OF DRAINAGE AREA
EXHIBIT E-1
REGIONAL VICINITY AND WATERSHED BOUNDARY MAP
EXHIBIT E-1

APPENDIX F

GEOLOGY

LOWER TWIN LAKE DAM

APPENDIX F

GEOLOGY

Lower Twin Lake Dam and reservoir area are located within the Glaciated Allegheny Plateau Section of the Appalachian Plateaus Physiographic Province. Deposits of glacial drift of variable thickness cover the entire area. The drift was deposited by the Wisconsin Ice Sheet during the Pleistocene period of geologic time.

The glacial drift is composed primarily of till which is a reddish brown, unsorted compact mixture of clay, silt, sand, gravel, and cobbles with occasional boulder sized pieces. The stone pieces are sub-angular to rounded and consist mainly of sandstone and siltstone derived from the Catskill formation, the dominant rock formation in the area. The clay content and compact nature of the till makes it a relatively impervious soil type.

Some deposits of glacial outwash are also found in the area. The outwash is composed of loose, poorly sorted to stratified deposits of silt, sand, and gravel. The outwash deposits are generally very pervious.

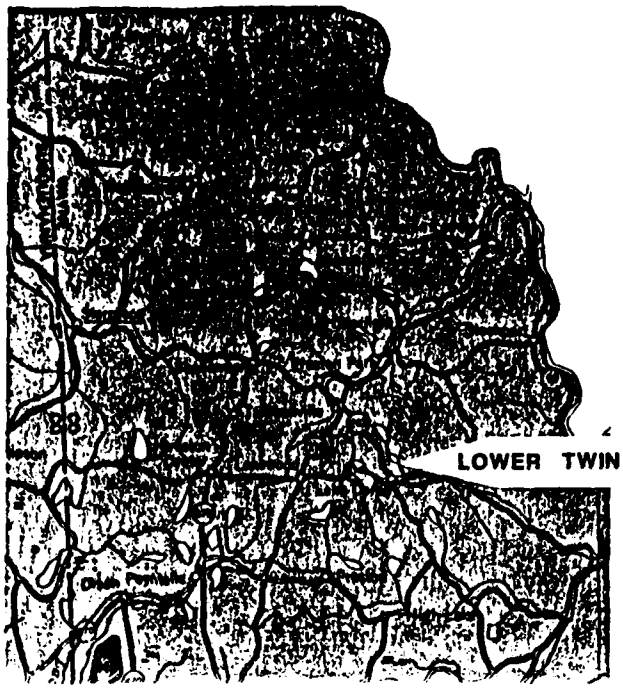
Other loose pervious soils in the area are the recent deposits of alluvial silt, sand, and gravel with some clay. These soils are localized and limited to streambeds and flood plain areas.

The bedrock underlying the entire dam and reservoir area is the Catskill Formation of the Susquehanna Group. This group of formations is of Upper Devonian age. The Catskill Strata generally consists of well-indurated red shale, siltstone, and fine sandstone with some gray, green, and brown shale, siltstone, and sandstone layers. Occasional conglomeratic layers are encountered. The red shales are the dominant lithology and the residual soils derived from this rock are usually high in clay and silt and contain numerous flaky and angular fragments and flat, slabby boulders. The right abutment at the dam is covered with many such flat, slabby boulders and the dry masonry walls of the dam itself are constructed from similar one and two-man sized boulders. About 350 feet downstream of the dam, near-horizontal sandstone ledges outcrop on the right side of the stream channel.

The regional structure of the bedrock in the area indicates that the bedrock underlying the dam and reservoir area is near-horizontal. The regional strike of the strata is northeast-southwest.

Although depth to the bedrock at the dam site is unknown, the steep earth slope on the left abutment indicates at least 14 feet of overburden soil.

Ref.: Ground Water of Northeastern Pennsylvania, Stanley W. Lohman 1937, Bulletin W-4, Pennsylvania Geologic Survey.



0 1 2 3 4 5 10 MILES

SCALE: 1 4 MILES

LEGEND

DEVONIAN

UPPER

CENTRAL AND EASTERN PENNSYLVANIA

Oswayo Formation

Brownish and greenish gray, fine and medium grained sandstones with some shales and scattered calcareous lenses; includes red shales which become more numerous eastward. Relation to type Oswayo not proved.

Dck

Catskill Formation

Chiefly red to brownish shales and sandstones, includes gray and greenish sandstone tongues named Elk Mountain, Honesdale, Shohola, and Delaware River in the east.

Dm

Marine beds

Gray to olive brown shales, graywackes, and sandstones; contains "Chemung" beds and "Portage" beds including Burket, Brallier, Harrell, and Trimmers Rock; Tully Limestone at base.

Ds

Susquehanna Group

Barbed line in "Chemung-Catskill" contact of Second Pennsylvania Survey County reports; barbs on "Chemung" side of line.

NOTE:

GEOLOGIC MAP AND LEGEND OBTAINED FROM GEOLOGIC MAP OF PENNSYLVANIA BY PA. TOPOGRAPHIC AND GEOLOGIC SURVEY, DATED 1960

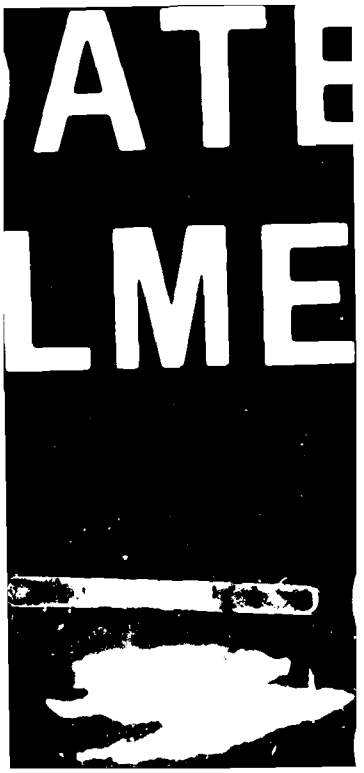
PHASE 1 INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

LOWER TWIN LAKE DAM
GEOLOGIC MAP

GEO - Technical Services, Inc.
HARRISBURG, PA

FEBRUARY 1981

EXHIBIT F


AT
LME